214-114-03

INSTALLATION RESTORATION PROGRAM
PHASE II - CONFIRMATION/QUANTIFICATION
STAGE I - FINAL REPORT
VOLUME I

SHEPPARD AIR FORCE BASE, TEXAS 76311

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April 1987

Final Report, October 1984 - June 1985

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PREPARED FOR:

HEADQUARTERS, AIR TRAINING COMMAND
COMMAND SURGEON'S OFFICE (HQ ATC/SGPB)
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BROOKS AIR FORCE BASE, TEXAS 78235-5501

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STAGE 1

FINAL REPORT
Volume I

FOR

SHEPPARD AFB, TEXAS 76311

HEADQUARTERS, AIR TRAINING COMMAND
RANDOLPH AIR FORCE BASE, TEXAS 78150

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Prepared by

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The Phase I (Records Search) Installation Restoration Program study at Sheppard AFB initially identified twenty-three individual sites of potential environmental concern. Of these twenty-three, eleven sites were identified as possibly containing hazardous waste. These sites were evaluated using the USAF Hazard Assessment Rating Methodology (HARM). Based upon the HARM scores, four of the eleven sites were identified for Phase II investigations. This investigation (Phase II Stage 1) was conducted between October 1984 and February 1985, and included geophysical surveys, the installation and sampling of nine ground-water monitoring wells, coring and sampling of shallow soils at two of the four sites, and sampling and analysis of surface water from seven locations near the waste sites.

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(Abstract continued)

Low levels of contaminants were detected in ground water near several sites. Of the inorganic and organic compounds detected, few exceeded regulatory standards or guidelines used for comparisons. Some of the inorganic compounds detected were lead, chromium, mercury and elevated total dissolved solids. Organic compounds detected were mainly solvents and some phenols. Similar compounds were detected in surface waters in the up and downgradient areas and in the ground water. These findings suggest that the compounds may not be solely attributable to impacts from the waste sites. The compounds in the surface water could be from urban and Base runoff with possible contributions from on-base wastewater treatment plants.

The shallow ground water at the Base is not used for drinking water. Additionally, the existing aquifers are thin and discontinuous on the Base so that no known immediate threat to human health exists.

Each of the four sites were categorized according to Air Force criteria; 1) no further investigation required, 2) additional work needed, and 3) institute remedial action. Additional work is recommended at the four sites considered in this IRP effort to further characterize them.

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PREFACE

Radian Corporation is the contractor for the Installation Restoration Program, Phase II, Stage 1 investigation at Sheppard Air Force Base, Texas. The work was performed under USAF Contract No. F33615-84-D-4402, Delivery Order 0003.

The field work consisted of geophysical surveys at four past waste disposal sites, the installation and sampling of nine groundwater monitoring wells, coring and sampling of shallow soils at two of the four sites, and sampling and chemical analysis of surface water from seven locations near the past waste disposal site.

The purpose of the investigation was to determine if environmental contamination had resulted from previous waste disposal practices. In addition, the investigation included an estimate of the magnitude and extent of any contamination, the identification of environmental consequences of any migrating pollutants, and recommendations to mitigate any possible pollution problems.

Key Radian project personnel are:

o Francis J. Smith	Contract Program Manager
o Nelson H. Lund	Project Director
o Rick A. Belan	Supervising Geologist and Principal Author
o Peter A. Waterreus	Field Geologist and Co-Author
o Jill P. Rossi	Cartographer

Radian would like to acknowledge the cooperation of the Sheppard Air Force Base Bioenvironmental Engineering and Civil Engineering Staffs, especially the assistance provided by Captain Susan Smits and MSgt William Burke.

The work reported herein was accomplished between October 1984 and June 1985. Major Dennis D. Brownley and Captain Patrick N. Johnson, Technical Services Division, USAF Occupational and Environmental Health Laboratory, were the Technical Program Managers.

Approved: ______________________
Francis J. Smith, P.E.
Contract Program Manager

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RADIAN CORPORATION

TABLE OF CONTENTS
(Volume I)

RADIAN CORPORATION

TABLE OF CONTENTS
(Volume I)

LIST OF FIGURES

LIST OF FIGURES (continued)

RADIAN CORPORATION

LIST OF TABLES

RADIAN CORPORATION

LIST OF TABLES (continued)

RADIAN CORPORATION

TABLE OF CONTENTS
(Volume II)

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Summary

EXECUTIVE SUMMARY

Background and Purpose

The Department of Defense (DOD) is conducting a nation-wide environmental program to evaluate past waste disposal practices on DOD property to investigate and control the migration of hazardous contaminants and to control hazards that may result from past waste disposal practices. The program consists of four phases: Phase I, Initial Assessment/Records Search; Phase II, Problem Confirmation; Phase III, Technology Base Development; and Phase IV, Remediation. The Installation Restoration Program (IRP) Phase II, is under the technical direction of the USAF Occupational and Environmental Health Laboratory, Brooks AFB, TX.

Phase I studies for the Sheppard AFB Installation Restoration Program were completed in February 1984. The purpose of the Phase I study was to conduct a records search for the identification of past waste disposal activities which may have caused ground-water contamination and the potential for migration of contaminants off-base.

Twenty-three sites at Sheppard AFB were identified initially as potential areas of environmental concern. These sites were further evaluated and those sites not having a potential for contamination were deleted from further consideration. The eleven remaining sites were rated using the Air Force Hazard Assessment Rating Methodology (HARM) and ranked based upon their HARM score. This rating system took into account such factors as the environmental setting, past waste management practices, the nature of the wastes present, and the potential for contaminant migration.

Of the eleven sites ranked, four sites were selected for Phase II (Stage 1) studies. Radian Corporation performed the Phase II (Stage 1) Field Evaluation under USAF Contract No. F33615-84-D-4402, Delivery Order 0003.

The Phase II (Stage 1) investigation's purpose was to determine whether environmental contamination had resulted from previous waste disposal practices at Sheppard AFB. In addition, the investigation included an estimate of the magnitude and extent of any contamination, the identification of environmental consequences of any migrating pollutants, and recommendations to mitigate any possible pollution problems.

Authorization to proceed on the Sheppard AFB Phase II (Stage 1) program was provided to Radian Corporation on 26 September 1984. Field activities took place from 29 October 1984 to 15 February 1985. The field work consisted of geophysical surveys at four waste sites, the installation and sampling of nine ground-water monitoring wells, coring and sampling of shallow soils at two of the four sites, and sampling and analysis of surface water from seven locations near the waste sites.

Site Locations and Sample Points

The Phase II (Stage 1) Field Evaluation consisted of investigating four waste sites:

- Waste Pits;
- Landfill No. 3 and Hardfill Area;
- Fire Protection Training Area No. 1; and
- Fire Protection Training Area No. 3.

The locations of the sites and sample points are shown on Figure 1.

Waste Pits

In 1966, three waste pits were excavated for the purpose of holding waste engine cleaning fluids and solvents from nearby maintenance buildings. These pits were located directly across Avenue H from Building 2325 (Figure 1). The three roughly square, unlined pits were each approximately 80 feet on

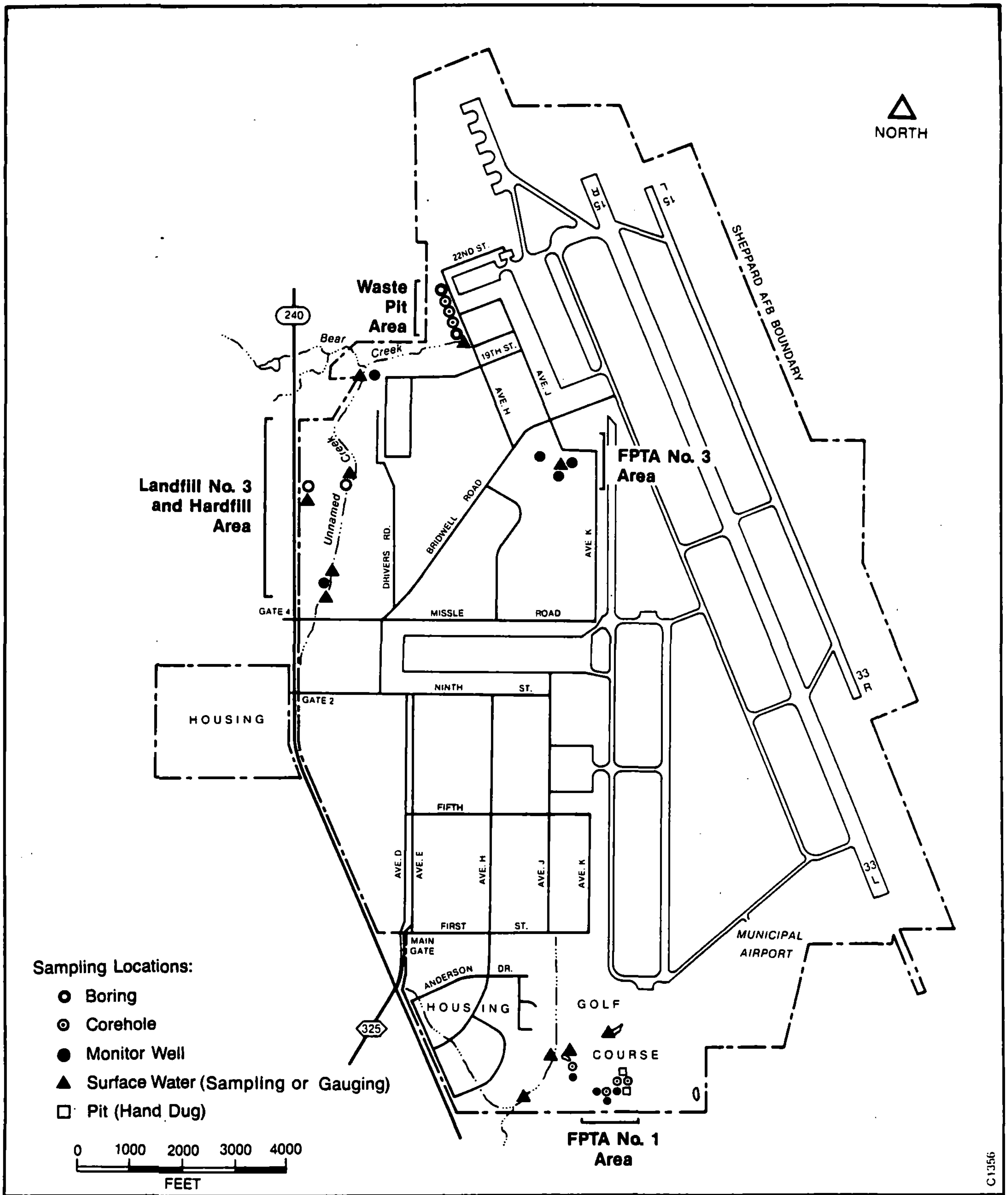


FIGURE 1. LOCATIONS OF IRP STUDY SITES SAMPLING AND GAUGING LOCATIONS, SHEPPARD AFB, TX

June 1986

a side and 10 feet deep. The pits were most actively used from 1966 to the mid-1970s (Engineering-Science, 1984). On one occasion in the late 1960s, an adjacent storm pond overflowed and carried an unknown quantity of the waste pit contents into the storm water system and hence into Bear Creek.

Bear Creek is the only surface drainage in the immediate vicinity of the waste pits and lies approximately 150 feet south of the site. Bear Creek frequently floods during high rainfall events.

Landfill No. 3 and Hardfill

Landfill No. 3, comprising about 60 acres at the northwest corner of the Base (Figure 1), has been used for disposal of Base refuse and hardfill from 1957 to 1972. The landfill was a trench and fill operation. In the 1960s, waste oils were disposed of by mixing with refuse, discharging into trenches, and covering with soil. The present hardfill area is adjacent to the area in which the oils were disposed, so these two areas were evaluated together. Aerial photographs taken during the Phase I site visit indicate that settling has occurred. These surface depressions collect rainfall (Engineering-Science, 1984).

The soils adjacent to the landfill are silty loam type soils, but the soils in the landfill are mixed. Due to the excavation and fill activities, the permeabilities in the area could be highly variable. A subsurface basal clay was observed in nearby test borings. Ground water is usually present at less than 10 feet below ground surface (Engineering-Science, 1984).

Fire Protection Training

The Fire Department at Sheppard AFB has operated several fire training sites at which fires were ignited and then extinguished. Fire extinguishing agents have included water, Aqueous Film Forming Foam (AFFF), protein foam, and Halon. Each of the two sites included in this investigation is illustrated in Figure 1 and is briefly described as follows:

Fire Protection Training Area No. 3 (FPTA No. 3)

FPTA No. 3, located adjacent to the northern corner of the old municipal runway (presently Bridwell Road), was activated in 1957 when another training site (FPTA No. 1) was closed for construction of the golf course. This site was in use at the time of this study. Contaminated fuel has been the primary material used for fire training exercises. Until 1982, no waste fuel collection system was in operation at the site. The system, installed in 1982, consists of a drainage, collection and piping system leading to an oil-water separator, and a water storage pond. The unburned fuel which drains into the oil-water separator is pumped to the storage tanks for reuse and the water phase flows to the pond for evaporation. Presently, burns are conducted approximately once per quarter. About 300 gallons of fuel are consumed per burn (Engineering-Science, 1984).

Visual examination of the area during the Phase I site visit indicated surficial contamination and a fuel odor. Due to the duration and frequency of operations and the lack of a waste oil reclamation facility until recently, a potential for contaminant migration exists for the site (Engineering-Science, 1984). Natural soils in this area are composed of silty loam with relatively low permeabilities. A nearby test boring at Building 2013 encountered clay from 0 to 15 feet below ground. Ground water may be present at less than 10 feet below ground surface (Engineering-Science, 1984).

Fire Protection Training Area No. 1 (FPTA No. 1)

FPTA No. 1, located at the Base golf course, was used as a fire protection training area from the 1940s until 1957. The site consisted of a depressed burning area and three old aircraft. A drum storage area north of and adjacent to the site was used to store between 100 and 200 55-gallon drums of contaminated oils, fuels and waste solvents from aircraft maintenance and industrial shop activities (Engineering-Science 1984).

The frequency and duration of burns during the 1940s is unknown. During the 1950s, the drums were transported by flat-bed truck from the drum storage area to the fire protection training site, the drums were drained and the burns conducted. During the 1950s, four or five burns occurred each weekend day. Each burn used about 400 to 500 gallons of material. As far as can be determined, no drainage collection system was operational at this site.

Visual examination of the area revealed no evidence that the site was once a fire protection training area. The site is presently well graded and is a part of the greens of the Base golf course. Due to the nature and duration of the activity at this site and the relatively shallow depth to ground water, a potential for contaminant migration exists since much of the unburned material probably seeped into the ground (Engineering-Science, 1984).

Sampling and Analytical Program

The sampling program at Sheppard AFB consisted of the collection of soil and water samples. Samples of soil for chemical analyses were retrieved from coreholes located at the Waste Pits. Samples of ground water were collected from monitor wells installed at the waste sites as part of this Phase II (Stage 1) IRP investigation and samples of surface water were collected from creeks and ponds in the vicinity of the sites.

All samples were transported to Radian Analytical Services for analyses. Sample splits were also provided to OEHL, Brooks AFB, Texas. The analytical parameters and sample types collected at the four waste sites are listed in Table 1.

TABLE 1. ANALYTICAL PARAMETERS FOR SOIL AND WATER SAMPLES, SHEPPARD AFB[1]

PARAMETER	WASTE PITS	LANDFILL NO. 3 AND HARDFILL AREA	FPTA NO. 3	FPTA NO. 1
Purgeable Halocarbons (EPA 601)	SW	SW, GW	SW, GW	SW, GW, S
Purgeable Aromatics (EPA 602)	SW	SW, GW	SW, GW	SW, GW, S
Oil and Grease	S, SW	SW, GW	SW, GW	SW, GW, S
Total Organic Carbon (TOC)	S, SW	SW, GW	SW, GW	SW, GW, S
pH	S, SW	SW, GW	SW, GW	SW, GW, S
TDS[2]	SW	SW, GW	SW, GW	SW, GW
Metals (Cr, Pb, and Hg)		SW, GW	SW, GW	
Phenol	S, SW			SW, GW, S
EP Toxicity and Ignitability	S		S	S

[1]GW - Ground Water
SW - Surface Water
S - Soil

[2]No TDS for soil samples

Field Program

Various field activities were performed at Sheppard AFB in support of the IRP Phase II (Stage 1) investigation. The activities consisted of geophysical surveys and coring at the two waste sites and the completion of nine ground-water monitor wells. The period of performance of the field activities was from 29 October 1984 through 15 February 1985.

Ground-Water Sampling: Ground-water samples were collected for analysis from the 9 ground-water monitor wells installed during Phase II (Stage 1).

Other Sampling: In addition to the monitor well sampling, selected surface water samples were also collected. Water samples were collected along Bear Creek and its tributary which flows through the Landfill No. 3 area and by the Waste Pits. An evaporation holding pond was sampled at the FPTA No. 3 area, while at FPTA No. 1, a pond and nearby stream were sampled.

Summary of Analytical Results

A total of 54 ground water, surface water and soil samples were collected for chemical analyses at Sheppard AFB. In addition, 6 soil samples from drill cuttings were analyzed for EP Toxicity and Ignitability for disposal purposes. None of the drill cutting samples were found to be hazardous based upon the EP Toxicity and Ignitability results. Analytical parameters are listed in Table 1. Analytical results indicate some organic and inorganic compounds were detected in both surface and groundwater at all sites from the two rounds of sampling conducted during this program. The principal inorganic parameters are total dissolved solids and metals (i.e., lead, mercury, and chromium). The organic compounds detected were mostly solvents and phenols.

While, in general, the same organic compounds were not detected or confirmed in both rounds of sampling, the same organic contaminants were detected in both rounds of sampling at monitor well MW-12. Organic contaminants were detected at least once in all 16 sampling points (9 monitor wells and 7 surface water points).

Chemical analyses of soil samples taken at the Waste Pits (18 samples) and FPTA No. 1 (4 samples) indicated contamination in the subsurface. Contaminants, consisting mostly of organic compounds, were detected between 10-15 feet below ground level. However, no obvious presence of the old waste pits was observed. On the other hand, at FPTA No. 1, analysis of four soil samples confirmed the presence of near-surface hydrocarbons.

Comparisons of Analytical Results to Standards or Guidelines

In order to determine possible water quality impacts of the local ground-water systems, the inorganic and organic compounds detected in the ground-water samples were compared to various criteria. These criteria were drawn from Federal and Texas State drinking water regulations for specific compounds detected as shown in Tables 2 and 3. The uses of human health criteria and standards for comparison of ground-water contamination at Sheppard AFB provides stringent evaluations of observed compound concentrations. Since the shallow ground water at the Base is not used as a water supply source, contaminants in-situ have neither human health nor environmental consequences. The potential for human contact and exposure exists when waters come to the land surface, either as seeps or as ground-water outflow to streams. Parameters that exceeded Federal and/or State standards are shown in: Table 4, Waste Pit, Landfill No. 3 and Hardfill Area; Table 5, FPTA NO. 3; and Table 6, FPTA No. 1.

Total dissolved solids (TDS) exceeded the Federal criteria at all sites. This included both surface and ground water as well as up- and downgradient locations. At one site (FPTA No. 3), one monitor well had higher TDS which may be related to an old evaporation pond. It appears that the elevated TDS for all locations is principally due to the natural substrate at Sheppard AFB and not to contamination.

TABLE 2. REGULATORY STANDARDS FOR INORGANIC COMPOUNDS DETECTED IN GROUND WATER

PARAMETER[1]	FEDERAL & STATE STANDARD
Total Dissolved Solids (S)	500.0 ppm [1,000.0 ppm]
Chromium (P)	0.05 mg/L
Lead (P)	0.05 mg/L
Mercury (P)	0.002 mg/L

[1] Federal and State of Texas primary and secondary drinking water standards denoted by (P) and (S), respectively. Secondary criteria based on aesthetics for water consumption while primary criteria are based upon health considerations. Regulatory references: Federal Register, 24 October 1980 and 7 September 1979; Texas Department of Health drinking water standards, revised 1 November 1980.

[] denotes State of Texas criteria is different from Federal criteria.

TABLE 3. REGULATORY GUIDELINES OR CRITERIA FOR ORGANIC COMPOUNDS DETECTED IN GROUND WATER

PARAMETER	HUMAN HEALTH EFFECTS[1] (ppb unless noted)	
Phenol (total)	3.5 ppm	
EPA Method 601 (Purgeable Compounds)		
1,1,1-Trichloroethane	18.4 ppm	
Trichloroethylene[2]	0.0	(27.0)[3]
1,2--Dichloroethane	0.0	(9.4)
Tetrachloroethylene	0.0	(8.0)
Methylene Chloride	0.15 mg/L[4]	
Chloroform, Bromoform, Bromodichloromethane, Dibromochloromethane	0.10 mg/L[5]	
EPA Method 602 (Purgeable Aromatics)		
Benzene	0.0	(6.6)[3]
Toluene	14.3 ppm	
Ethyl Benzene	1.4 ppm	
1,2-Dichlorobenzene	4000.0	

(1) U.S. EPA estimate of safe levels of toxicants in drinking water for human health effects (Federal Register, 28 November 1980).

(2) Also known as Trichloroethene.

(3) EPA has recommended human health effects criteria of zero (0) for carcinogens, but notes that this level may currently be nonfeasible. The Agency provides criteria for achieving various levels of protection on an interim basis. The levels which may result in a $10E^{-5}$ incremental increase of cancer risk over a lifetime are presented in parenthesis in ppb unless noted. These risks would permit one case of cancer per 100,000 people exposed. (Federal Register, 28 November 1980.)

(4) U.S. EPA SNARL Review, December 1980.

(5) Criteria for total trihalomethane.

TABLE 4. WASTE PITS, LANDFILL NO. 3 AND HARDFILL AREA, SUMMARY OF GROUND WATER ANALYTE RESULTS EXCEEDING FEDERAL AND/OR STATE REGULATIONS OR GUIDELINES

	ANALYTE AND RESULTS (1)	
	TOTAL DISSOLVED SOLIDS (S) (mg/L)	MERCURY (P) (mg/L)
GUIDELINE (2)	500 (3) [1,000]	0.002
SAMPLING SITE		
SURFACE WATER		
SW-1 (Waste Pits)	- (4)	-
	1,000 *	-
SW-2 (Landfill No. 3)	-	-
	1,200 *	-
SW-5 (Landfill No. 3)	-	-
	1,100 *	-
GROUND WATER (Landfill No. 3)		
MW-4	5,800	0.0066
	4,000 *	-
MW-4 QC	5,600	0.0038
MW-7	12,000	0.0036
	12,000 *	-

(1) Federal and State of Texas primary and secondary drinking water standards denoted by (P) and (S), respectively. Secondary criteria based on aesthetics for water consumption while primary criteria are based upon health considerations. Regulatory references: Federal Register, 24 October 1980 and 7 September 1979; Texas Department of Health drinking water standards, revised 1 November 1980.
(2) [] Denotes State of Texas criteria which is different from Federal criteria.
(3) Guideline concentration in mg/L, analytical results in (mg/L).
(4) - Denotes that guidelines were not exceeded.
* Asterisk denotes results from the second round of sampling.

TABLE 5. FIRE PROTECTION TRAINING AREA (FPTA) NO. 3, SUMMARY OF GROUND WATER ANALYTE RESULTS EXCEEDING FEDERAL AND/OR STATE REGULATIONS OR GUIDELINES

SAMPLING SITE		ANALYTE AND RESULTS (1)		
		TOTAL DISSOLVED SOLIDS (S) (mg/L)	LEAD (P) (mg/L)	BENZENE (ug/L)
	GUIDELINE (2)	500 (3) [1,000]	0.05	6.6 (4)
SURFACE WATER				
SW-6		1,000	- (5)	-
		- *	-	10.0 (6)
GROUND WATER				
MW-8		9,100	-	-
		7,800 *	-	-
MW-9		1,500	-	-
		1,200 *	-	-
MW-10		2,700	0.058	-
		1,500 *	-	-

(1) Federal and State of Texas primary and secondary drinking water standards denoted by (P) and (S), respectively. Secondary criteria based upon aesthetics for water consumptions while primary criteria are based upon health considerations. Regulatory references: Federal Register, 24 October 1980 and 7 September 1979; Texas Department of Health drinking water standards, revised 1 November 1980.
(2) [] denotes State of Texas criteria which is different from Federal criteria.
(3) Guideline concentration in mg/L, analytical results in (mg/L).
(4) EPA has recommended human health effects criteria of zero for carcinogens, but notes that this level may currently be nonfeasible. The Agency provides criteria for achieving various levels of protection on an interim basis. The levels which may result in a 0.00001 incremental increase of cancer risk over a lifetime are presented in ppb, analytical results are in (ug/L). (Federal Register, 28 November 1980.)
(5) - denotes that guidelines were not exceeded.
(6) Identity of detected compound was not confirmed by second column GC analyses.
* Asterisk denotes results from the second round of sampling.

TABLE 6. FIRE PROTECTION TRAINING AREA (FPTA) NO. 1, SUMMARY OF GROUND WATER ANALYTE RESULTS EXCEEDING FEDERAL AND/OR STATE REGULATIONS OR GUIDELINES

		ANALYTE AND RESULTS (1)(2)
		TOTAL DISSOLVED SOLIDS (S) (mg/L)
	GUIDELINE (2)	500 (3) [1,000]
SAMPLING SITE		
SURFACE WATER		
SW-7		1,400
		1,800 *
SW-8		-
		950 *
SW-9		-
		760 *
GROUND WATER		
MW-11		530
		- *
MW-12		850
		760 *
MW-13		1,200
		1,200 *
MW-14		1,900
		1,800 *
MW-14 QC		1,700 *

(1) Federal and State of Texas primary and secondary drinking water standards denoted by (P) and (S), respectively. Secondary criteria based upon aesthetics while primary criteria are based upon health considerations. Regulatory references: Federal Register, 24 October 1980 and 7 September 1979; Texas Department of Health drinking water standards, revised 1 November 1980.

(2) [] denotes State of Texas criteria which is different from Federal criteria.

(3) Guideline concentration in mg/L, analytical results in (mg/L).

* Asterisk denotes results from the second round of sampling.

Conclusions

The main purpose of the IRP Phase II (Stage 1) investigation was to confirm the absence or presence of subsurface contamination due to the old waste sites at Sheppard AFB. Various inorganic and organic compounds were confirmed in soils, ground water and surface water at the Base. Most compounds detected did not exceed Federal or State criteria. This investigation also confirmed contamination sources previously known (an old evaporation pond at FPTA No. 3 and hydrocarbon wastes at FPTA No. 1).

Although contaminants were detected in ground water in up-and downgradient areas, there appears to be no immediate or significant health threat as the ground water is on-Base and it is not used as a drinking water source. Also, compounds were detected in surface waters up- and downstream. This suggested that the compounds may be a result of either urban or Base runoff, or may possibly be originating from on-Base treatment plant discharge.

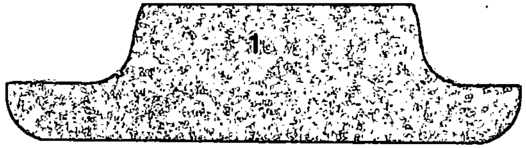
Recommendations

According to U.S. Air Force criteria, each of the four sites has been assigned to one of the following categories: sites where no further action is required (Category I); sites requiring additional monitoring or work to assess the extent of current or future contamination (Category II); and sites ready for remedial action (Category III).

All four sites investigated during the Phase II (Stage 1) program fall into Category II, requiring additional monitoring to more clearly define and assess the extent and character of contamination. Evidence of some soil and/or ground-water contamination was found at every site. However, the hydrogeologic and chemical data for the sites were not sufficient to adequately define the physical environment to the extent required for the design and implementation of remedial actions and assignment to Category III. Table 7 provides the rationale for assignment of all Phase II (Stage 1) sites to Category II and general recommendations for additional activities.

TABLE 7. CATEGORIZATION OF SHEPPARD AFB IRP, PHASE II (STAGE 1) SITES

CATEGORY	SITE	PRINCIPAL RATIONALE
II	Waste Pits	No ground water was encountered. Although low potential for contaminant migration was determined, further characterization of contamination is recommended.
II	Landfill and Hardfill Area	Additional characterization of the local ground-water systems, and contaminant verification is needed.
II	FPTA No. 3	Characterization of an old evaporation pond suspected of contaminating ground water is necessary. Verification of ground water and contaminant flow direction beyond the site and upgradient of the site is necessary.
II	FPTA No. 1	Characterization of hydrocarbon waste is needed and definition of a contamination plume is required.


1

1.0 INTRODUCTION

The Department of Defense (DOD) is conducting a nation-wide program to evaluate past waste disposal practices on DOD property, to investigate and control the migration of hazardous contaminants and to reduce hazards that may result from these past waste disposal practices. This program, the Installation Restoration Program (IRP), consists of four phases: Phase I, Initial Assessment/Record Search; Phase II, Problem Confirmation; Phase III, Technology Base Development; and Phase IV, Remediation. The United States Air Force (USAF) initiated an IRP investigation at Sheppard Air Force Base near Wichita Falls, Texas; Radian Corporation performed the Phase II (Stage 1) Field Evaluation under USAF Contract No. F33615-84-D-4402, Delivery Order 0003.

1.1 Purpose of the Investigation

The purpose of the Phase II (Stage 1) investigation was to determine if environmental contamination has resulted from past waste disposal practices at Sheppard AFB. In addition, the investigation included an estimate of the magnitude and extent of any contamination, the identification of environmental consequences of any migrating pollutants and the recommendation of additional investigations necessary to identify the magnitude, extent and direction of movement of any discovered contaminants.

1.2 Duration of the Program

Authorization to proceed on the Sheppard AFB Phase II (Stage 1) program was received on 26 September 1984. Field activities were accomplished from 29 October 1984 to 15 February 1985. The field work consisted of geophysical surveys at the waste sites, the installation and sampling of nine ground-water monitoring wells, coring and sampling of shallow soils at two of the four sites, sampling and analysis of surface and ground water from areas near the waste sites.

1.3 Waste Disposal Practices

Management of wastes at Sheppard AFB was reviewed as part of the IRP Phase 1 investigation conducted in 1983. Results of the investigation show that waste generated during most of the history at Sheppard AFB has generally been handled on-site; however, since the early to mid-1970s, solid and chemical wastes have been disposed off-Base by private waste disposal firms. Recently, on Base disposal operations consisted of hardfilling close to the waste pit area. The hardfilling activities ended in early 1985.

Disposal of solid waste occurred from the 1940s to 1972 at three locations within the Base. The landfills were constructed by excavating a series of parallel trenches, depositing waste, and covering the refuse with soil. The depth of the trenches was generally about 14 feet below the land surface. The landfills are still visible as indicated by the hummocky ground surface. These features correspond to the former trenches which have undergone differential compaction. Most of the waste deposited in the landfills consisted of general Base refuse, fly ash, waste treatment sludge, and some industrial waste oils. Burns, without the use of added fuels, occurred in the landfill trenches until 1968.

On-site disposal of liquid wastes and sludges has occurred from the 1940s to the mid-1970s. From the 1940s to the late 1960s, combustible industrial waste (i.e., oils, hydraulic fluids and solvents) were disposed of primarily by burning at one of the Fire Protection Training Areas. Some of these wastes were also disposed of in the landfills. Disposal of engine cleaning fluids and solvents was accomplished by placing the material into three unlined pits located in the northwest area of the Base. These waste pits were most actively used in the mid-1970s. Another waste pit north of the waste treatment facility was used in the 1950s as a storage pond for waste oils and fuels from the old engine test cells. The oils in this pit were burned on several occasions in the 1950s.

1.4 Site Descriptions

The Phase II (Stage 1) Field Evaluation consisted of investigating four waste sites. These represent landfills, evaporation ponds, and fire training areas. The locations of the sites investigated are shown on Figure 1-1. A description of each site is provided based upon the Phase I report (Engineering-Science, 1984).

Waste Pits

In 1966, three waste pits were excavated for the purpose of holding waste engine cleaning fluids and solvents from nearby maintenance buildings. These pits were directly west of Avenue H and north of Bear Creek (Figure 1-1). Based upon aerial photography (undated) the roughly square unlined pits were approximately 80 feet on each side and 10 feet deep. On one occasion in the late 1960s, an adjacent storm pond overflowed and carried an unknown quantity of the waste pit contents into the storm sewer system and hence into Bear Creek. The pits were actively used from 1966 to the mid-1970s (Engineering-Science, 1984).

Bear Creek is the only surface drainage in the immediate vicinity of the waste pits and lies approximately 150 feet south of the site. Bear Creek frequently floods during high rainfall events.

Landfill No. 3 and Hardfill

Landfill No. 3, comprising about 60 acres at the northwest corner of the Base (Figure 1-1) was used for Base refuse and hardfill from 1957 to 1972. The landfill was a trench and fill operation. In the 1960s, waste oils and refuse were placed into trenches and covered with soil. The present hardfill area is adjacent to the area in which the oils were disposed, so these two areas were evaluated as one. Aerial photographs taken during the Phase I site

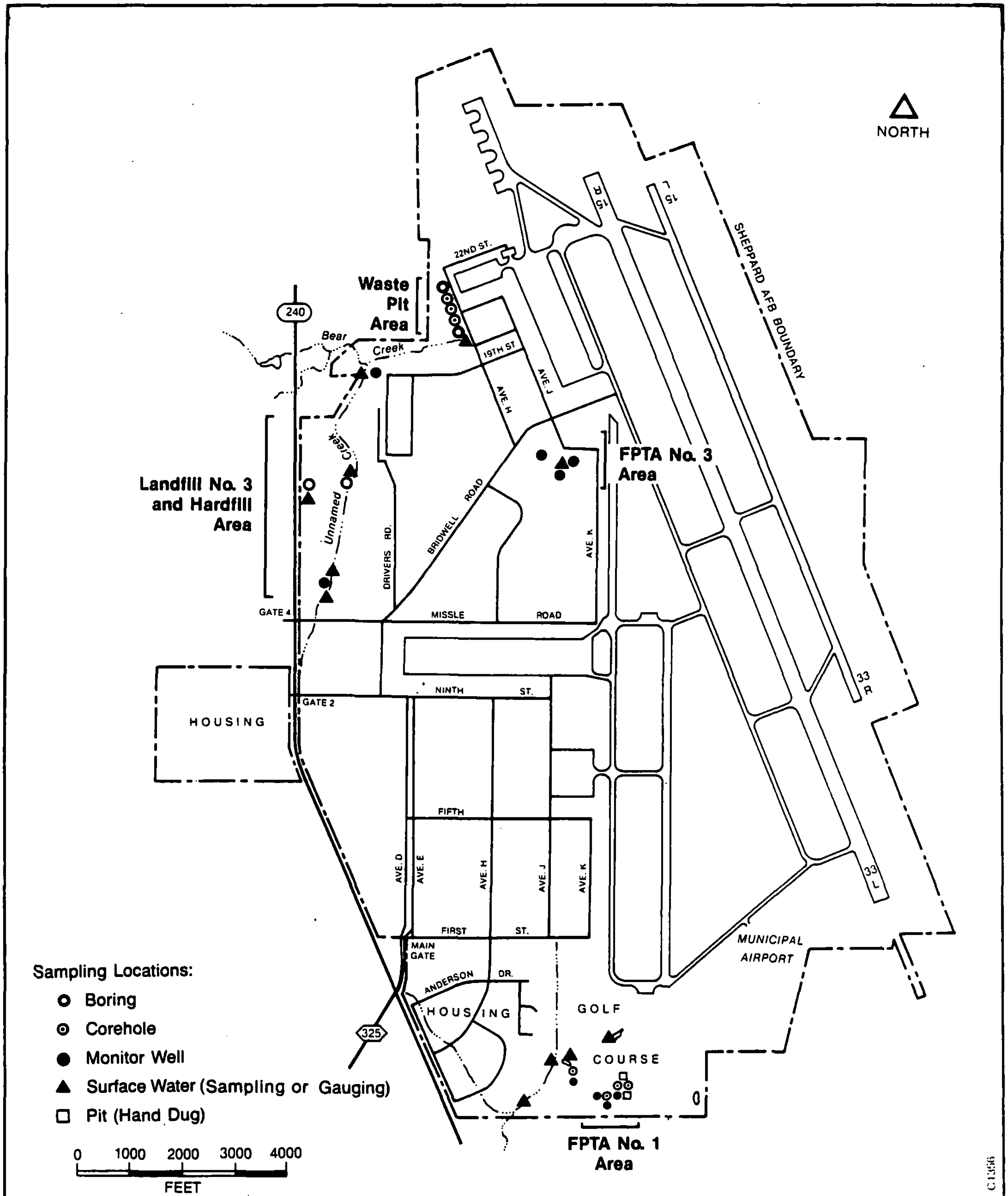


FIGURE 1-1. LOCATIONS OF IRP STUDY SITES, SHEPPARD AFB, TX

June 1986

visit indicated that settling has occurred. These depressed areas collect rainfall (Engineering-Science, 1984).

Soils in the landfill area have been disturbed but adjacent areas have silty loam type soils. Due to the excavation and fill activities, the permeabilities in the area could be highly variable, but a subsurface base of clay was evident from nearby test borings. Ground water is usually present at less than 10 feet below ground (Engineering-Science, 1984).

Fire Protection Training

The Fire Department at Sheppard AFB has operated several fire training sites at which fires were ignited and then extinguished. Fire extinguishing agents have included water, Aqueous Film Forming Foam (AFFF), protein foams, and Halon. Each of the sites under this investigation is illustrated in Figure 1-1 and is briefly described as follows:

Fire Protection Training Area No. 3 (FPTA No. 3)

FPTA No. 3, located adjacent to the northern corner of the old municipal runway (presently Bridwell Road), was activated in 1957 when FPTA No. 1 was closed for construction of the golf course. This site was in use at the time of this study. Contaminated fuel has been the primary material used for fire training exercises. Until 1982, no waste fuel collection system was in operation at the site. The drainage and collection system, installed in 1982, consists of drainage, collection and piping systems leading to an oil-water separator, and a water storage pond. The unburned fuel which drains into the oil-water separator is pumped to the storage tanks for reuse, and the water phase flows to the pond for evaporation. Presently, burns are conducted approximately once per quarter. About 300 gallons of fuel are consumed per burn (Engineering-Science, 1984).

Reconnaissance of the area during the Phase I site visit revealed surficial contamination and a fuel odor. Due to the duration and frequency of operations and, until recently, the lack of a waste oil reclamation facility, a potential for contaminant migration exists for the site (Engineering-Science, 1984).

Natural soils in this area are composed of silty loam with relatively low permeabilities. A nearby test boring at Building 2013 encountered clay from 0 to 15 feet below ground. Ground water may be present at less than 10 feet below ground surface (Engineering-Science, 1984).

Fire Protection Training Area No. 1 (FPTA No. 1)

FPTA No. 1, located at the Base golf course, was used as a fire protection training area from the 1940s until 1957. The site consisted of a depressed burning area and three old aircraft. A drum storage area north of and adjacent to the site was used to store between 100 and 200 55-gallon drums of contaminated oils, fuels and waste solvents from aircraft maintenance and industrial shop activities (Engineering-Science, 1984).

The frequency and duration of burns during the 1940s is unknown. During the 1950s, the drums were transported by flat-bed truck from the drum storage area to the fire protection training site, the drums were drained and burns occurred. During the 1950s, four or five burns occurred each weekend day, and each burn constituted about 400 to 500 gallons of material. As far as can be determined, no drainage collection system was operational at this site.

Visual examination of the area presently reveals no remaining sign that the site was once a fire protection training area. The site is presently well graded and is a part of the greens of the Base golf course. Due to the nature and duration of the activity at this site and the relatively shallow depth to ground water, a potential for contaminant migration exists since much of the unburned material probably seeped into the ground (Engineering-Science, 1984).

Sampling and Analytical Program

The sampling program at Sheppard AFB consisted of the collection of soil and water. Samples of soil for chemical analyses were retrieved from coreholes located at the Waste Pits, and FPTA No. 1. Samples of surface and ground water were collected from various locations: monitor wells installed at the waste sites as part of this Phase II (Stage 1) IRP investigation, and from creeks and ponds in the vicinity of the sites.

All samples were transported to Radian Analytical Services for analysis. Sample splits were also provided to OEHL, Brooks AFB, Texas. The analytical parameters for soil and water samples collected at Sheppard AFB are shown in Table 1-1.

Field Program

Various field activities were performed at Sheppard AFB in support of the IRP Phase II (Stage 1) investigation. The activities consisted of the completion of nine ground-water monitor wells, eight geophysical surveys, and coring at two of the four designated waste sites. The period of performance of the field activities was 29 October 1984 through 15 February 1985.

The following paragraphs contain descriptions of the various field techniques used in the Sheppard AFB Phase II investigation. These techniques included geophysical surveying, hollow-stem augering and hand augering, monitor well installation, and soil and ground-water sampling.

Geophysical Surveying: Geophysical surveying was performed in order to accurately define the area of investigation at four waste sites. Two sites (Waste Pits, and Fire Protection Training Area No. 1) no longer receive wastes and are used for other Base activities. The Landfill No.3/Hardfill Area receives limited amounts of hardfill at the present time. Except for the Landfill No. 3 area, no surface remnants of the waste disposal facilities are visible. One site (Fire Protection Training Area No. 3) is still actively used for training and is clearly distinguishable by the on-site equipment.

TABLE 1-1. ANALYTICAL PARAMETERS FOR SOIL AND WATER SAMPLES, SHEPPARD AFB[1]

PARAMETER	WASTE PITS	LANDFILL NO. 3 AND HARDFILL AREA	FPTA NO. 3	FTPA NO. 1
Purgeable Halocarbons (EPA 601)	SW	SW, GW	SW, GW	SW, GW, S
Purgeable Aromatics (EPA 602)	SW	SW, GW	SW, GW	SW, GW, S
Oil and Grease	S, SW	SW, GW	SW, GW	SW, GW, S
Total Organic Carbon (TOC)	S, SW	SW, GW	SW, GW	SW, GW, S
pH	S, SW	SW, GW	SW, GW	SW, GW, S
TDS[2]	SW	SW, GW	SW, GW	SW, GW
Metals (Cr, Pb, and Hg)		SW, GW	SW, GW	
Phenol	S, SW			SW, GW, S
EP Toxicity and Ignitability	S		S	S

[1] GW - Ground Water
SW - Surface Water
S - Soil

[2] No TDS for soil samples

The primary geophysical technique used was electromagnetics for determining waste site boundaries and contamination migration. The electromagnetic surveys were conducted with EM-31 and EM-34 systems providing depths of investigations ranging from about 10 to 45 feet. Two other systems, consisting of resistivity surveys and magnetometry, were utilized to aid in monitor well planning and site clearance for monitor well drilling.

The resistivity surveys were conducted as soundings to provide data on the subsurface lithology in planning monitor well installation. The resistivity surveys were conducted with a Bison Model 350 Earth Resistivity meter.

Magnetometry readings were conducted at selected resistivity survey sounding locations. This was to provide indications of the presence of any large metal objects that could be hazardous to monitor well installation activities. An EDA Model PPM-500 magnetometer was used for the surveying.

Drilling Techniques: Drilling and coring at Sheppard AFB were accomplished using hollow-stem augering for shallow exploratory borings and monitor wells. Hand augering was also used for selected soil sampling. The augering method was selected on the basis of the anticipated depth of completion, need for detailed control of sampling and water level observations, and geologic conditions expected at various depths. The hollow-stem auger was used for the drilling and emplacement of two-inch diameter monitor wells.

A hollow-stem auger drilling rig, a Mobile B-53, was used to perform shallow coring and soil sampling. The hollow-stem method allowed for an accurate examination of soil conditions, identification of any waste material and contaminated soil, and recovery of soil samples for analyses. The holes were drilled dry; no drilling fluids or additives were used. Depending upon augering conditions, soil samples were collected either with a pushed Shelby tube or split-spoon sampler (both are hollow tubes driven in advance of the auger at regular intervals). This procedure is prescribed by the American Society for Testing Materials as Method ASTM D-1586.

A 3-1/2 inch diameter hand auger was used at FPTA No. 1 to obtain soil and/or waste samples. The samples were analyzed and the results were used to determine the presence or absence of any waste products at FPTA No. 1.

Ground-Water Sampling: Ground-water samples were collected for analysis from the 9 ground-water monitor wells installed under Phase II (Stage 1).

Other Sampling: In addition to the monitor well sampling, surface water samples were also collected at several locations. Water samples were collected along Bear Creek and its tributary which flows through the Landfill No. 3 area and by the Waste Pits. An evaporation holding pond was sampled at the FPTA No. 3 area while at FPTA No. 1, a pond and nearby stream were sampled.

1.5 Investigation Personnel

The Sheppard AFB IRP Phase II (Stage 1) investigation was conducted by individuals from the Austin office of Radian Corporation. Francis J. Smith, Contract Program Manager, was responsible for the contractual administration of this program. The Project Director was Nelson H. Lund, P.E., a Radian Senior Engineer, who coordinated the program activities. Rick A. Belan, Staff Hydrogeologist and Certified Professional Geological Scientist, served as technical advisor to the project. Field activities, consisting of the geophysical surveys, coring, monitoring well installation and sampling, were supervised by Rick A. Belan and Peter A. Waterreus. Cartographic and technical illustrations were prepared by Jill P. Rossi. Resumes for these individuals are provided in Appendix K.

2

2.0 ENVIRONMENTAL SETTING

This discussion of the Sheppard AFB environmental setting was principally derived from the Installation Restoration Program Phase I Records Search report (Engineering-Science, 1984). Information developed from that report is supplemented by the literature and the general findings of this study. The following sections describe the environmental setting of Sheppard AFB. Basic features and history of the sites investigated in this study are also discussed here.

2.1 General Geographic Setting and Land Use

Sheppard AFB is located on 5,249 acres in the north-central portion of Texas, just four miles north of the city of Wichita Falls in Wichita County. The base is bordered by agricultural lands on the north and east, a road with limited residential and commercial development on the south, and State Highway 240 with commercial development on the west. The general location of Sheppard AFB is illustrated in Figures 2-1, and 2-2 (Engineering-Science, 1984).

2.2 Physiographic and Topographic Features

Sheppard AFB is located within the Central Rolling Red Plains physiographic province of north-central Texas. This province is characterized by rolling topography, although large flat areas are present (USDA, 1977). Bear Creek and a tributary of Plum Creek are the main watercourses on the Base.

Topography

The topography of Sheppard AFB is rolling, typical of the general province topography. The highest hill on the Base is south of the regional hospital (Building 1200) and rises to an approximate elevation of 1,075 feet

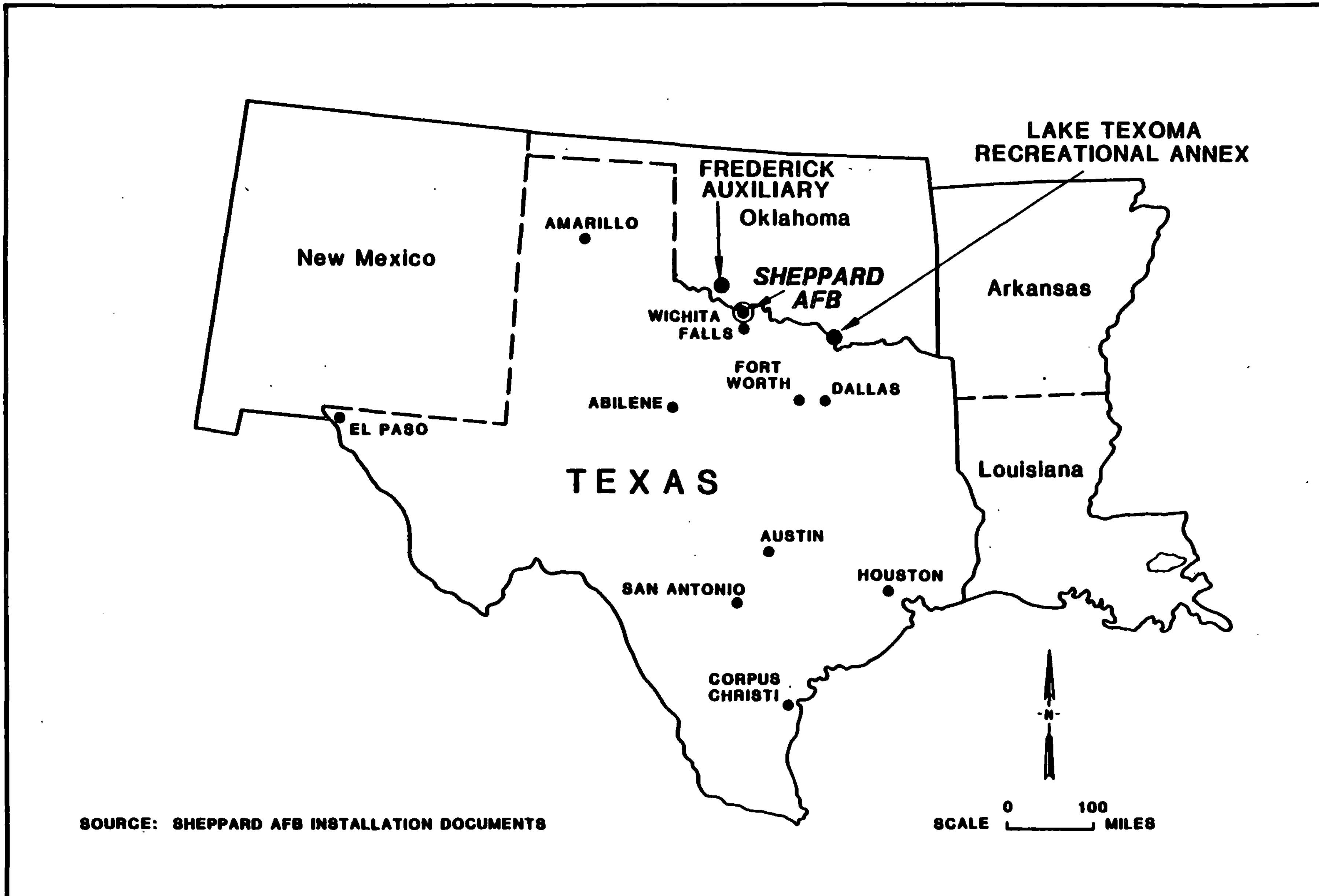


FIGURE 2-1. REGIONAL LOCATION MAP, SHEPPARD AFB, TX.

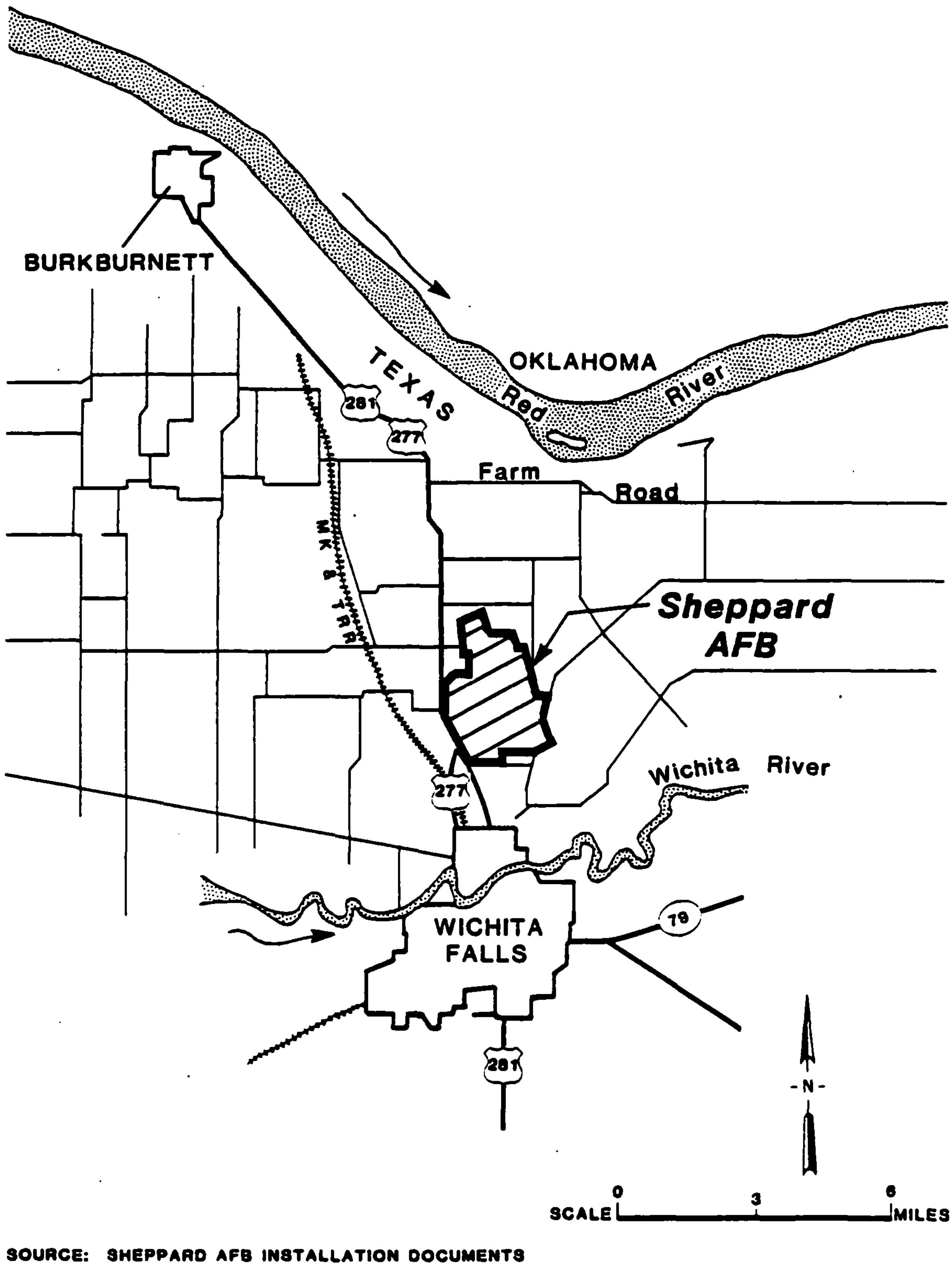


FIGURE 2-2. GENERAL LOCATION OF SHEPPARD AFB, TX.

above the National Geodetic Vertical Datum of 1929 (NGVD). A second, but less prominent hill (1,025 feet NGVD), is located on the Base golf course. The runway area as well as the area in the northeastern portion of the base are relatively flat with elevations ranging from 990 to 1,015 feet NGVD. These areas are dissected by several streams which have almost vertical cut banks three to five feet into the land surface.

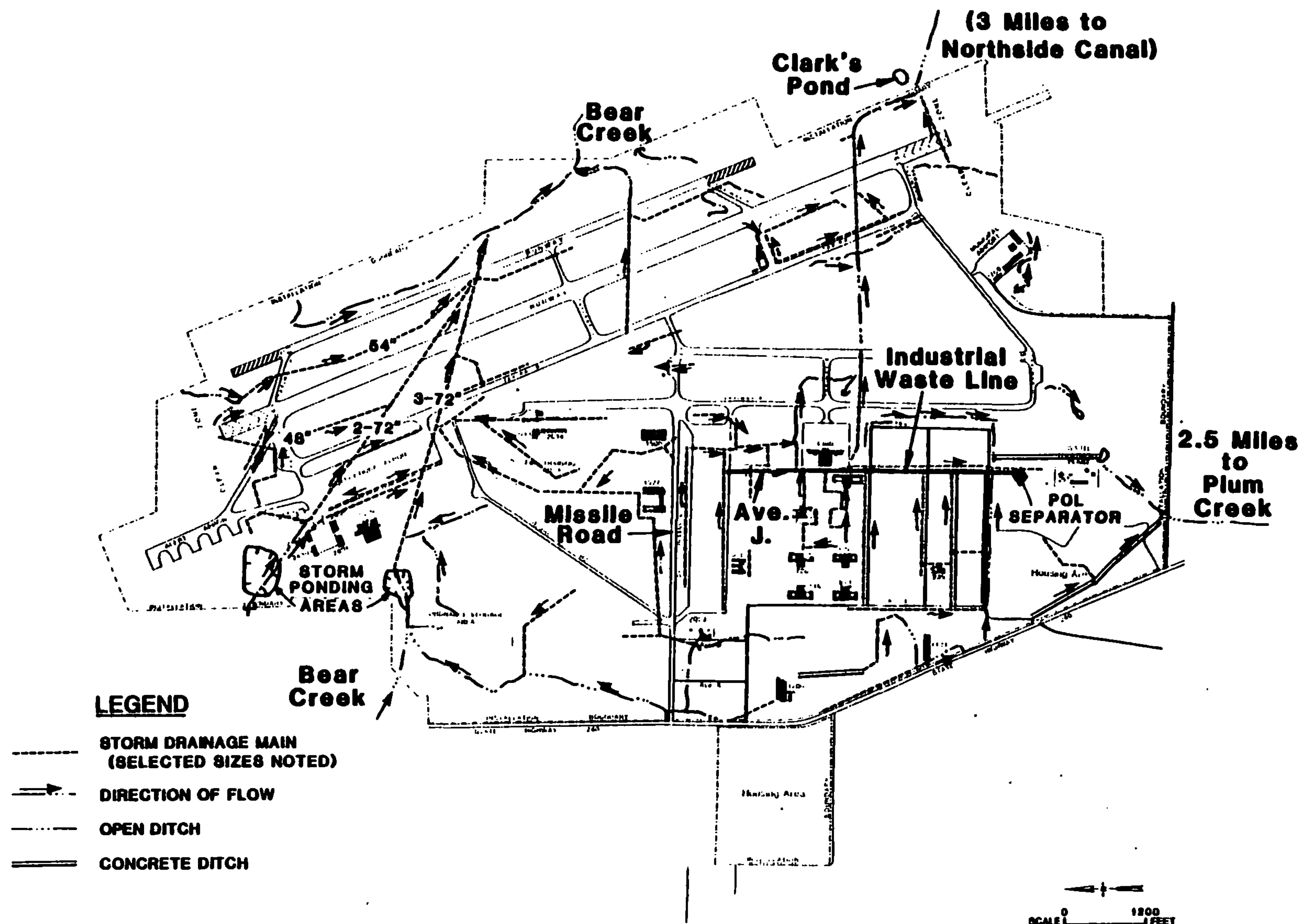
Drainage

Sheppard AFB is located in the Red River Drainage Basin of north-central Texas. The drainage on Sheppard AFB is controlled by open and concrete-lined ditches, as well as underground storm drainage mains (Figure 2-3). Drainage from areas north of Missile Road is generally to the north, east and southeast, while drainage from areas south of Missile Road is generally to the south and southeast. Drainage north of Missile Road is joined by discharge from an off-base wastewater treatment plant owned by Wichita Falls and then flows into Bear Creek near the Base boundary (Figure 2-3).

In the northern portion of the Base, significant drainage features are the storm ponding areas. One is located west of Building 2320, and the other is located southwest of the Alert Apron. Bear Creek flows through the former area prior to entering three 72-inch diameter underground pipes. Erosion is moderately developed in the area where storm drainage is heaviest. Vegetation (grasses and primary tree growth) is abundant in the areas.

A significant drainage feature in the southern portion of the Base is the industrial waste line located along Avenue J (Figure 2-3). The industrial waste line is a closed discharge line for waste oil and fuel. Waste oil and fuel flows into open drains along the flight apron prior to entering the industrial waste line.

Away from the Base, surface-water drainage enters Bear Creek, North Side Canal or Plum Creek (Figure 2-4). Drainage through the underground pipes



SOURCE: SHEPPARD AFB INSTALLATION DOCUMENTS

FIGURE 2-3. SURFACE DRAINAGE, SHEPPARD AFB, TX.

Engineering Science, February 1984

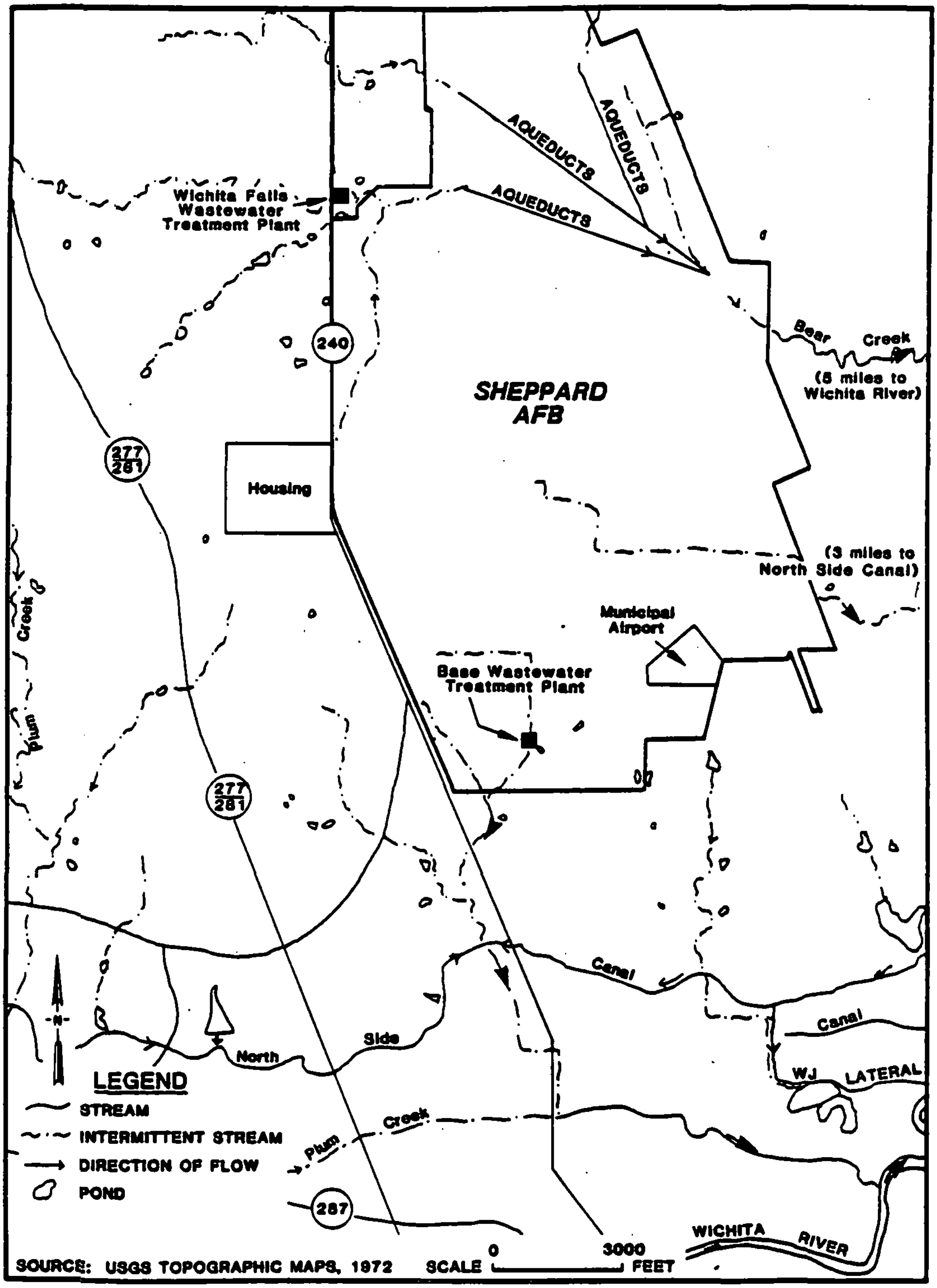


FIGURE 2-4. SHEPPARD AFB AREA SURFACE DRAINAGE MAP.

or aqueducts in the northern portion of the Base enters Bear Creek and flows approximately five miles to the Wichita River. Drainage in the southeastern portion of the Base enters a tributary of North Side Canal, which is approximately three miles southeast of the Base. Drainage in the southwestern portion of the Base, along with discharges from the Base wastewater treatment plant, flows into a tributary and then into Plum Creek approximately 2.5 miles south of the Base.

2.3 Geologic and Hydrogeologic Conditions

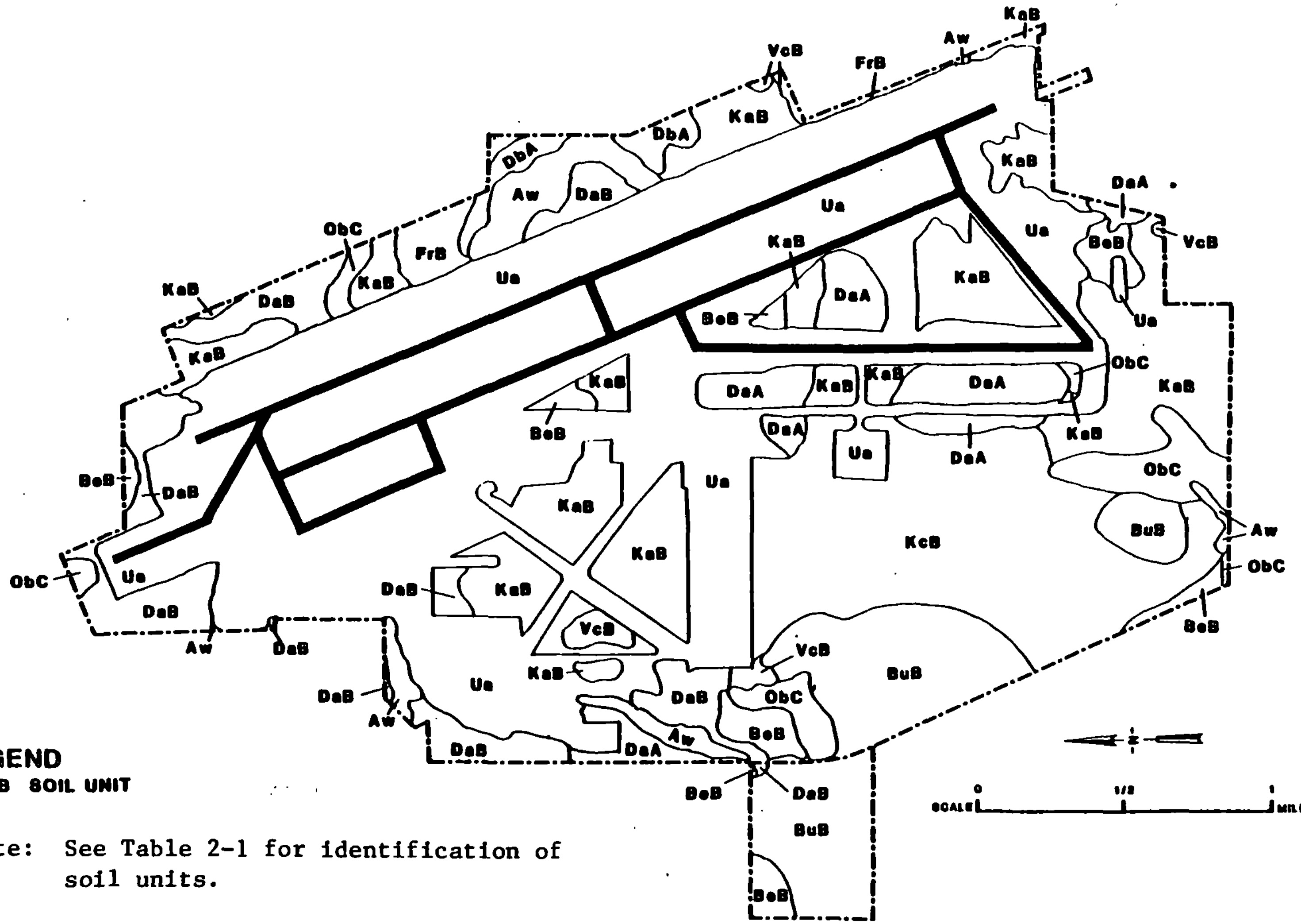
Soils

The soils of Sheppard AFB are typically sandy, silty, and clayey loam. Loam is a soil with varying proportions of sand, clay, and organic matter. Figure 2-5 is the Sheppard AFB soils map. The soil symbol as shown on the map corresponds to the soil descriptions and engineering properties as summarized in Table 2-1. Asa and Port soils are frequently flooded while Oben fine sandy loam soils are susceptible to wind erosion.

The soil property of concern in assessing the potential for surface-water infiltration is vertical permeability. The vertical permeability values for the soils on the Base range from less than 4.2×10^{-5} centimeters per second (cm/sec) to 1.4×10^{-3} cm/sec (Richardson, et al., 1977), which indicates that surface water infiltration is at a moderate to slow rate. The Soil Conservation Service (SCS) has ranked the on-Base soils as having several limitations for use as septic tank absorption fields. The SCS limitations are based on shallow depth to rock and slow percolation rates.

Lithology

Sheppard AFB is located in the outcrop area of the Wichita Group (Figure 2-6). These strata are composed of shale, sandstone and limestone. Table 2-2 summarizes the hydrogeologic units and their water-bearing characteristics. The only water-bearing units of importance in the vicinity of the



LEGEND

BeB SOIL UNIT

Note: See Table 2-1 for identification of soil units.

SOURCE: RICHARDSON, et al., 1977

FIGURE 2-5. GENERAL SOILS MAP, SHEPPARD AFB, TX.

TABLE 2-1. SHEPPARD AFB SOIL DESCRIPTIONS AND ENGINEERING PROPERTIES

SYMBOL ON FIGURE 2-5	UNIT DESCRIPTION	DEPTH (inches)	PERMEABILITY (centimeters/second)	SEPTIC TANK ABSORPTION FIELD USE LIMITATION
Aw	Asa and Port soils, frequently flooded, silty clay loam	0 - 18	4.2×10^{-4} - 1.4×10^{-3}	Severe[1]; floods.
		18 - 60	4.2×10^{-4} - 1.4×10^{-3}	
BeB	Bluegrove loam, 1 to 3 percent slopes	0 - 8	4.2×10^{-4} - 1.4×10^{-3}	Severe; depth to rock; percolation slow.
		8 - 34	1.4×10^{-4} - 4.2×10^{-4}	
		34 - 84	(no value; weakly cemented sandstone)	
BuB	Bluegrove - Urban land complex, 1 to 3 percent slopes	0 - 8	4.2×10^{-4} - 1.4×10^{-3}	Severe; depth to rock; percolation slow.
		8 - 34	1.4×10^{-4} - 4.2×10^{-4}	
		34 - 84	(no value; weakly cemented sandstone)	
DeA	Deandale silt loam, 0 to 1 percent slopes	0 - 12	4.2×10^{-4} - 1.4×10^{-3}	Severe; percolation slow.
		12 - 90	$<4.2 \times 10^{-4}$	
DeB	Deandale silt loam, 1 to 3 percent slopes	0 - 12	4.2×10^{-4} - 1.4×10^{-3}	Severe; percolation slow.
		12 - 90	$<4.2 \times 10^{-4}$	
DbA	Deandale silt loam, loamy substratum, 0 to 1 percent slopes	0 - 8	4.2×10^{-4} - 1.4×10^{-3}	Severe; percolation slow.
		8 - 74	$<4.2 \times 10^{-5}$	
		74 - 88	1.4×10^{-4} - 4.2×10^{-4}	
		88 - 100	4.2×10^{-4} - 1.4×10^{-3}	
FrB	Frankirk loam, 1 to 3 percent slopes	0 - 7	4.2×10^{-4} - 1.4×10^{-3}	Severe; percolation slow.
		7 - 55	1.4×10^{-4} - 4.2×10^{-4}	

(continued)

TABLE 2-1. (continued)

SYMBOL ON FIGURE 2-5	UNIT DESCRIPTION	DEPTH (inches)	PERMEABILITY (centimeters/second)	SEPTIC TANK ABSORPTION FIELD USE LIMITATION
KaB	Kamay silt loam, 1 to 3 percent slopes	0 - 10	$4.2 \times 10^{-4} - 1.4 \times 10^{-3}$	Severe; percolation slow.
		10 - 100	$<4.2 \times 10^{-5}$	
KcB	Kamay - Urban land complex, 0 to 3 percent slopes	0 - 10	$4.2 \times 10^{-4} - 1.4 \times 10^{-3}$	Severe; percolation slow.
		10 - 100	$<4.2 \times 10^{-5}$	
ObC	Oben fine sandy loam, 1 to 5 percent slopes (W)	0 - 6	$4.2 \times 10^{-4} - 1.4 \times 10^{-3}$	Severe; depth to rock.
		6 - 17	$4.2 \times 10^{-4} - 1.4 \times 10^{-3}$	
		17 - 36	(no value; weakly cemented sandstone)	
Ua	Urban land		(Too variable to be rated)	
VcB	Vernon clay loam, 1 to 3 percent slopes	0 - 7	$1.4 \times 10^{-4} - 4.2 \times 10^{-4}$	Severe; percolation slow.
		7 - 34	$<4.2 \times 10^{-5}$	
		34 - 60	$<4.2 \times 10^{-5}$	

NOTES:

[1] Severe means that soils properties are so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance is required.

w = Signs of wind erosion are present.

Source: Richardson, et. al., 1977.

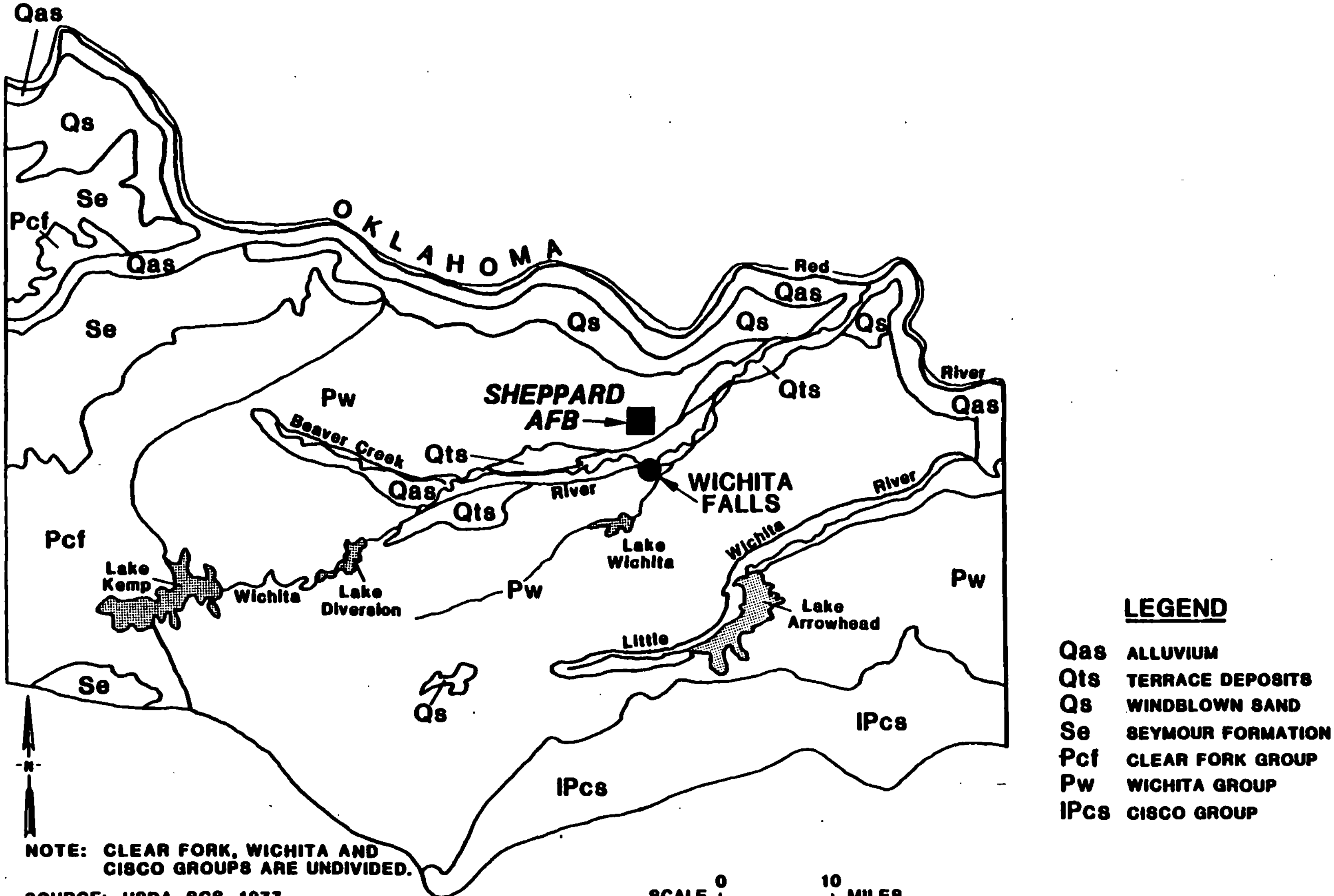


FIGURE 2-6. REGIONAL GEOLOGY, VICINITY OF SHEPPARD AFB, TX

TABLE 2-2. HYDROGEOLOGIC UNITS AND THEIR WATER-BEARING CHARACTERISTICS IN THE VICINITY OF SHEPPARD AFB

SYSTEM	SERIES	GROUP	HYDROGEOLOGIC UNIT	HYDROGEOLOGIC CLASSIFICATION	APPROXIMATE THICKNESS (FEET)	DOMINANT LITHOLOGY	WATER-BEARING CHARACTERISTICS
Quaternary	Recent to Pleistocene		Alluvium, Wind-blown Sand and Terrace Deposits	Unconfined Aquifers	80	Sand, silt, clay, and gravel.	Moderately transmits water; yields small to moderate amounts of water to wells along rivers and major tributaries.
			Seymour Formation	Unconfined Aquifer	112	Sand, silt, clay, and gravel.	Moderately transmits water; yields small to moderate amounts of northwest corner of Wichita County.
Permian	Leonard	Clear Fork Group (undivided)		Unconfined Aquifer	1,350	Dolomite, limestone, and shale.	Moderately transmits water; yields small to moderate amounts of water to wells in extreme northwest corner of Wichita County.
	Wolfcamp	Wichita Group (undivided)		Unconfined and Confined Aquifers	670	Shale, sandstone, and limestone.	Moderately transmits water; yields small amounts of water which is usually too highly mineralized for use.
Pennsylvanian	Upper	Cisco Group (undivided)		Unconfined and Confined Aquifers	1,000	Shale, sandstone limestone, and conglomerate.	

Source: USDA, SCS, 1977; Price, 1979 and Baker, et al., 1963.

Base are the alluvium and the terrace deposits south of the Red River. These units supply ground water to the cities of Burkburnett, Thornberry, and Friberg Cooper.

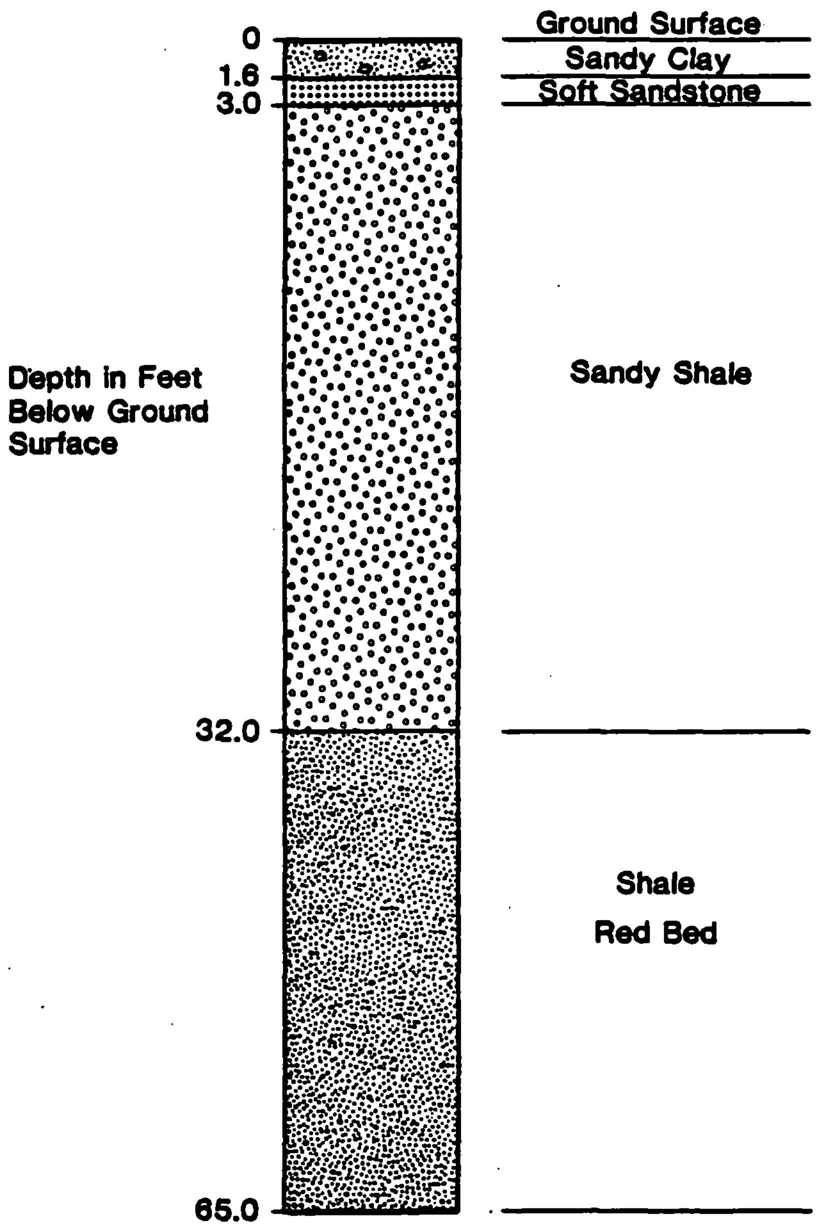
The sediments on the Base overlying the Wichita Group have been penetrated by numerous test borings. The deepest boring (No. H-1) was 65 feet deep and encountered shale bedrock at 32 feet below ground (Figure 2-7). Softer formations of sandstone and sandy shale were encountered above the shale bedrock. The shale is a distinctive red color, hence the driller's nomenclature is "shale redbed" on most boring logs. Two generalized subsurface cross section locations are shown on Figure 2-8. Figures 2-9 and 2-10 are cross sections A-A' and B-B', respectively. The preponderance of clay and shale is very evident. The depth to the top of bedrock (shale or sandstone) ranges from 2 to 32 feet below ground.

Structure

The geologic structure of Wichita County consists primarily of folds with little surface expression. Structural deformation is pre-Pennsylvanian in age. The folded terrain occurs to the north and west of Wichita Falls and has no impact on Sheppard AFB surficial formations. The greatest surface expression of folding is located 25 miles from Wichita Falls in the northwest portion of Wichita County near the city of Electra. The Electra arch runs west and east through Wilbarger and Wichita counties. The bend flexure trends northward from the Llano-Burnet uplift, extending through Young and Archer counties into Wichita County, where it deviates to the northwest in joining the Electra arch.

Surface Water Use

Surface water in the immediate vicinity of Sheppard AFB is used for contact and non-contact recreation, and propagation of fish and wildlife (Texas Department of Water Resources, 1981). Irrigation of crop land is also a major use of the surface water.



SOURCE: SHEPPARD AFB INSTALLATION DOCUMENTS

FIGURE 2-7. SHEPPARD AFB TEST BORING LOG NO. H-1.

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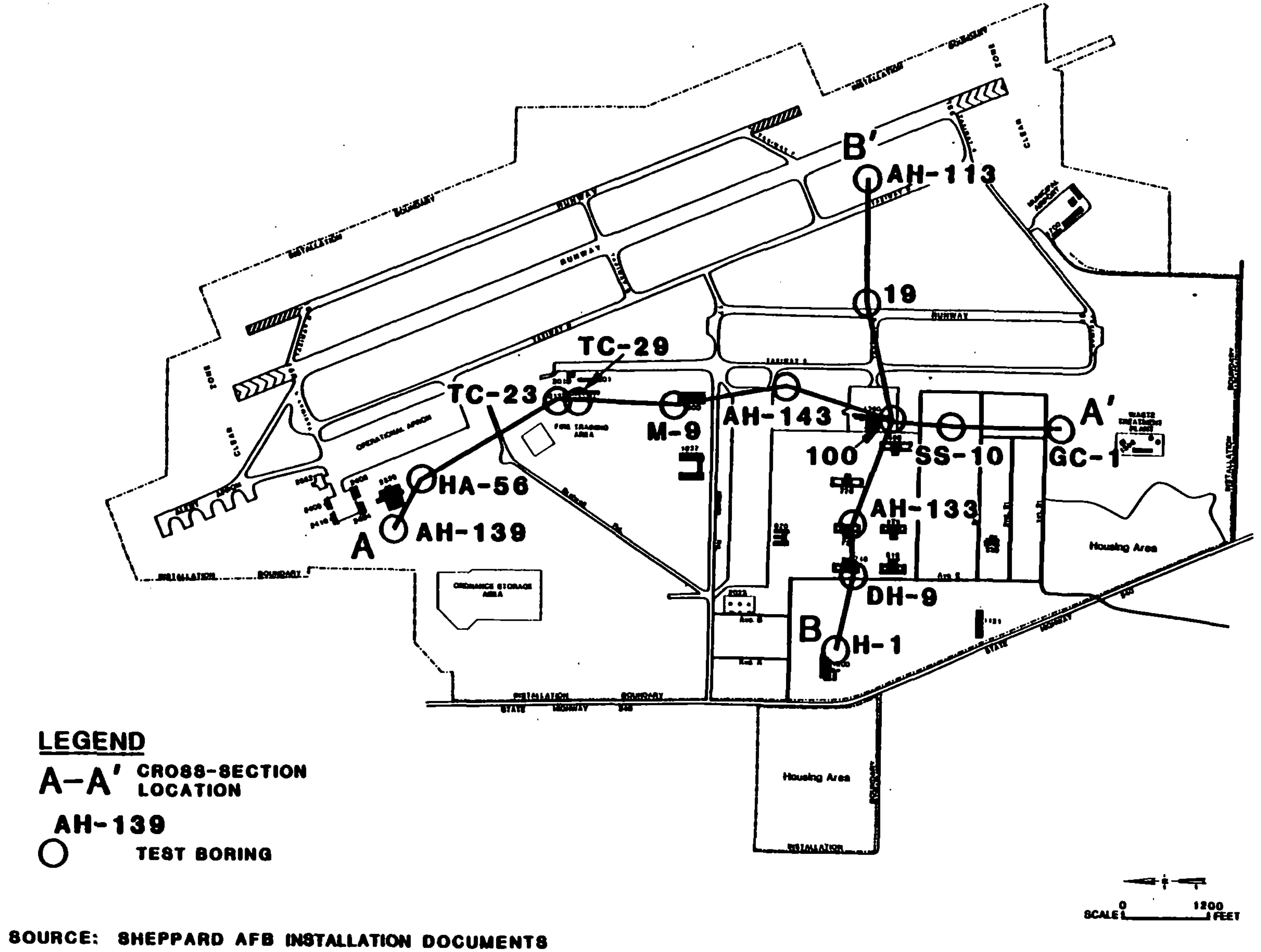
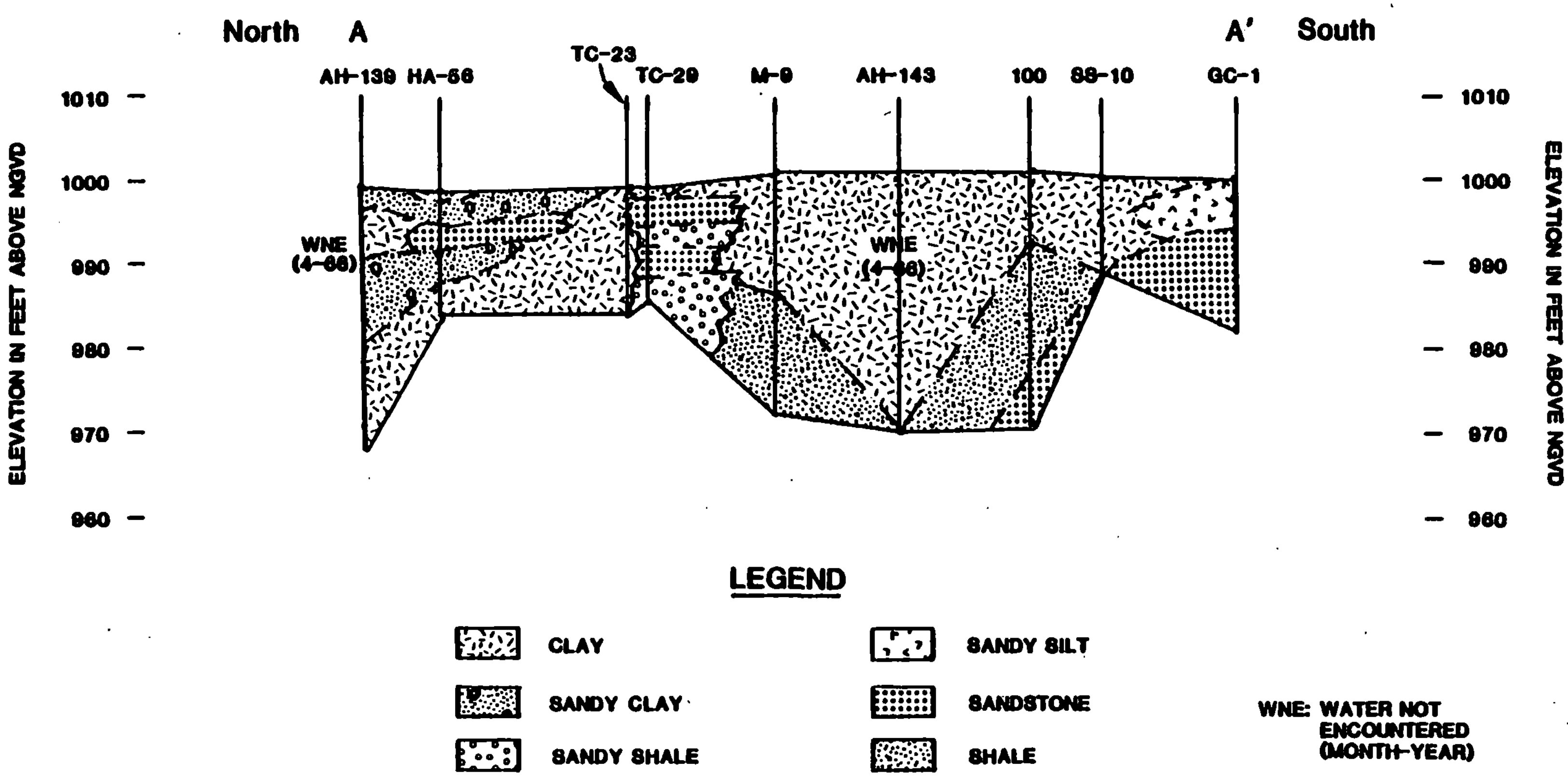


FIGURE 2-8. GENERAL LOCATION OF CROSS SECTIONS A-A' AND B-B'
SHEPPARD AFB, TX.

Engineering Science, February 1984



NOTE: GROUND WATER PRESENCE OR ABSENCE WAS NOT RECORDED ON SOME TEST BORING LOGS. VERTICAL SCALE IS GREATER THAN HORIZONTAL SCALE.

SOURCE: SHEPPARD AFB INSTALLATION DOCUMENTS

SCALE 0 1200 FEET

FIGURE 2-9. IRP PHASE I CROSS SECTION A-A', SHEPPARD AFB, TX.

Engineering Science, February 1984

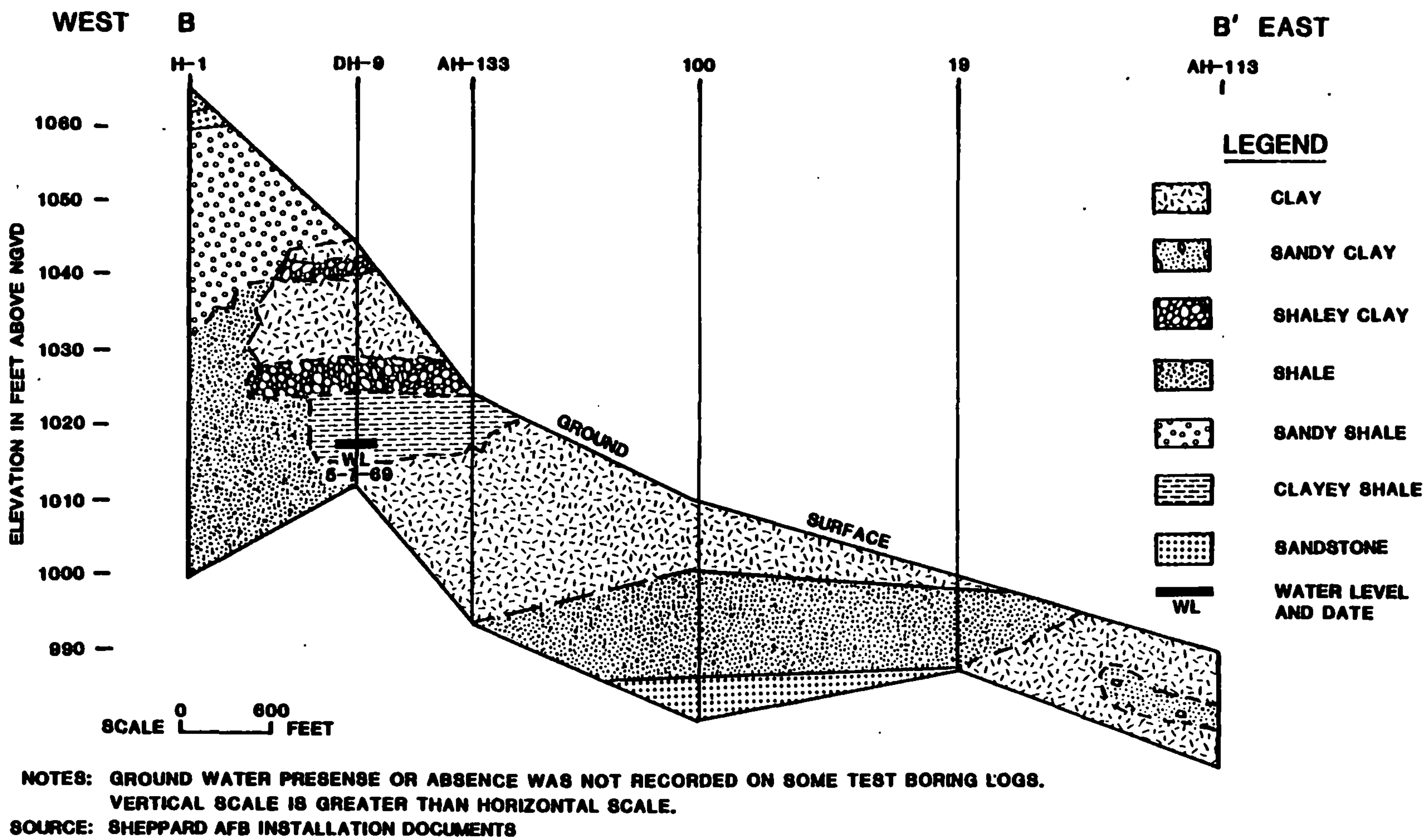


FIGURE 2-10. IRP PHASE I CROSS SECTION B-B', SHEPPARD AFB, TX.

Engineering Science, February 1984

Public water supply for Wichita Falls is obtained principally from Lake Arrowhead and Lake Kickapoo, which along with Lake Kemp and Lake Diversion are located southwest and south of the Base (Texas Department of Water Resources, 1983). The Base obtains its water supply from Wichita Falls. The Wichita Falls surface-water supply intakes are upstream of Sheppard AFB discharges.

The municipality of Byers, Texas is the next potential downstream water user. Byers is about 25 miles downstream and closest to the Wichita River. It presently uses ground water for the municipal water supply, while maintaining a small reservoir on the river permitted for recreational use (Moltz, 1986).

Occurrence of Ground Water

The ground-water resources in the immediate vicinity of Sheppard AFB are not abundant due to the occurrence of shale bedrock and the abundance of clay. The bedrock itself and overlying clay deposits have low permeabilities; therefore, they do not yield significant volumes of water to wells. Reports by Baker, et al. (1963), Fink and Merritt (1976), USDA (1977), Muller and Price (1979), and Price (1979) describe the ground-water resources of the region.

Surface soils and upper sections of weathered bedrock may contain shallow (probably perched) local aquifers. The lithology of weathered bedrock is highly variable, characterized by clay, sandy clay, soft sandstone, sandy silt, and isolated sections of sandy shale. Most of the bedrock is composed of clay (see cross-sections, Figures 2-9 and 2-10). When water is present, it occurs at depths of ten to thirty feet below ground (from installation test borings). In some areas of the Base, no ground water was encountered, suggesting that these deposits may contain water only seasonally, or ground water may be limited areally due to changes in lithology. Test boring data suggest that the geologic material occurring on Base becomes finer-grained, tighter and therefore less permeable with increasing depth (for example, below 32 feet at Boring H-1). These geologic conditions would tend to restrict the vertical movement of ground water in favor of lateral movement of ground water. In summary, it is likely that the shallow materials receive recharge from precipitation or from infiltration of stream flow. Likewise, discharge of ground water is directed to drainage alignments and not to deeper aquifers. Information about specific ground-water flow directions in these deposits is not available.

Areas near the Operational Apron contained ground water at 1.5 feet below ground (Stroman, 1983). The presence of shallow ground water in the Operational Apron area may be due to several reasons such as the:

- o Close proximity of subsurface drainage pipes;
- o Relatively permeable crushed limestone base underlying the Apron; and
- o Effect of heat on the Apron during hot summer days.

The summer heat may cause an upward movement of ground water in response to vapor pressure gradients created by the evaporation of near-surface moisture. This phenomenon has been called "evaporative pumping." A subsurface drainage system has been installed to alleviate high ground-water levels in this area.

Ground-Water Quality

Ground-water quality in the immediate vicinity of the Base is poor due to limited recharge by precipitation and highly mineralized waters related to oil and gas development. Numerous oil and gas wells in the area have encountered mineralized water in the Wichita and Cisco Groups (undivided) (Baker, et al., 1972). One test well drilled west of the Base in the 1920s encountered natural gas at shallow depths of 50 and 120 feet deep. One dry test well was drilled 1,850 feet deep on the property of the old Wichita Falls

Airport. The date of drilling and exact location are unknown (Heidecker, 1983). The quality of ground water in the alluvium and terrace deposits north of the Base is good and wells in the area along the Red River supply potable water.

Ground-Water Use

Ground water is not used on Sheppard AFB. In the Wichita Falls area, ground water is used in very limited quantities for drinking water and livestock. When ground water is used in the community, it is supplied by a limited number of very shallow dug or drilled wells. The wells are placed adjacent to ponds so as to withdraw water from the shallow sediments which are saturated by pond water infiltration. A chlorination unit is usually connected to the well. No records of wells in the vicinity are available (Threadgill, 1984).

In the nearby cities of Burkburnett, Thornberry, and Friberg Cooper, ground water is used from wells tapping the alluvium terrace deposits. The average depth of the approximately 100 wells is 40 to 45 feet below ground. The wells yield between 3 and 50 gallons per minute (Sprole, 1983). Those wells are approximately four miles north or northeast of Sheppard AFB. The alluvium and terrace deposits are not considered to be hydraulically connected to the limited ground water underlying Sheppard AFB.

2.4 Site Descriptions

Phase I studies for the Sheppard AFB Installation Restoration Program were completed by Engineering-Science in February 1984. The purpose of the Phase I study was to conduct a records search for the identification of past waste management activities which may have caused ground-water contamination and the migration of contaminants off-Base.

Twenty-three sites at Sheppard AFB were identified initially as potential areas of environmental concerns. These initial sites were further evaluated and those sites not having a potential for contamination were deleted from further consideration. The eleven remaining sites were rated using the Air Force Hazard Assessment Rating Methodology (HARM) and ranked based upon their HARM score. This system took into account such factors as the site environmental setting, the nature of the wastes present, past waste management practices, and the potential for contaminant migration.

Of the eleven individual sites ranked, four sites were selected for Phase II studies. The general features of the sites evaluated in this Phase II (Stage 1) study are discussed below as they are presented in the 1984 Phase I report. Detailed features of each site are discussed in Sections 3.0 and 4.0. The locations of each of the sites are illustrated in Figure 1-1.

2.4.1 Waste Pits

In 1966, three waste pits were excavated for the purpose of holding waste fluids and solvents from engine cleaning in nearby maintenance buildings. These pits were located west of Avenue H and across from Building 2325 (Figure 2-11). The three square unlined pits were approximately 80 feet on each side and 10 feet deep. On one occasion in the late 1960s, an adjacent storm pond overflowed and carried some of the waste pit contents into the storm water system and hence into Bear Creek. The pits were most actively used from 1966 to the mid-1970s (Engineering-Science, 1984). According to former base employees, the pits were removed in the mid-1970s. No further information was uncovered regarding the extent of removal. During the field activities hardfilling of areas near the waste pits was conducted by the base.

2.4.2 Landfill No. 3 and Hardfill Areas

Landfill No. 3, comprising about 60 acres at the northwest corner of the Base, was operated from about 1957 until 1972 (Figure 2-12). The landfill area is located east of State Highway 240, and in an area bounded approximately by Missile Road, the Motor Pool area, the Munitions Storage area, and the City of Wichita Falls treatment facility property. The material disposed of

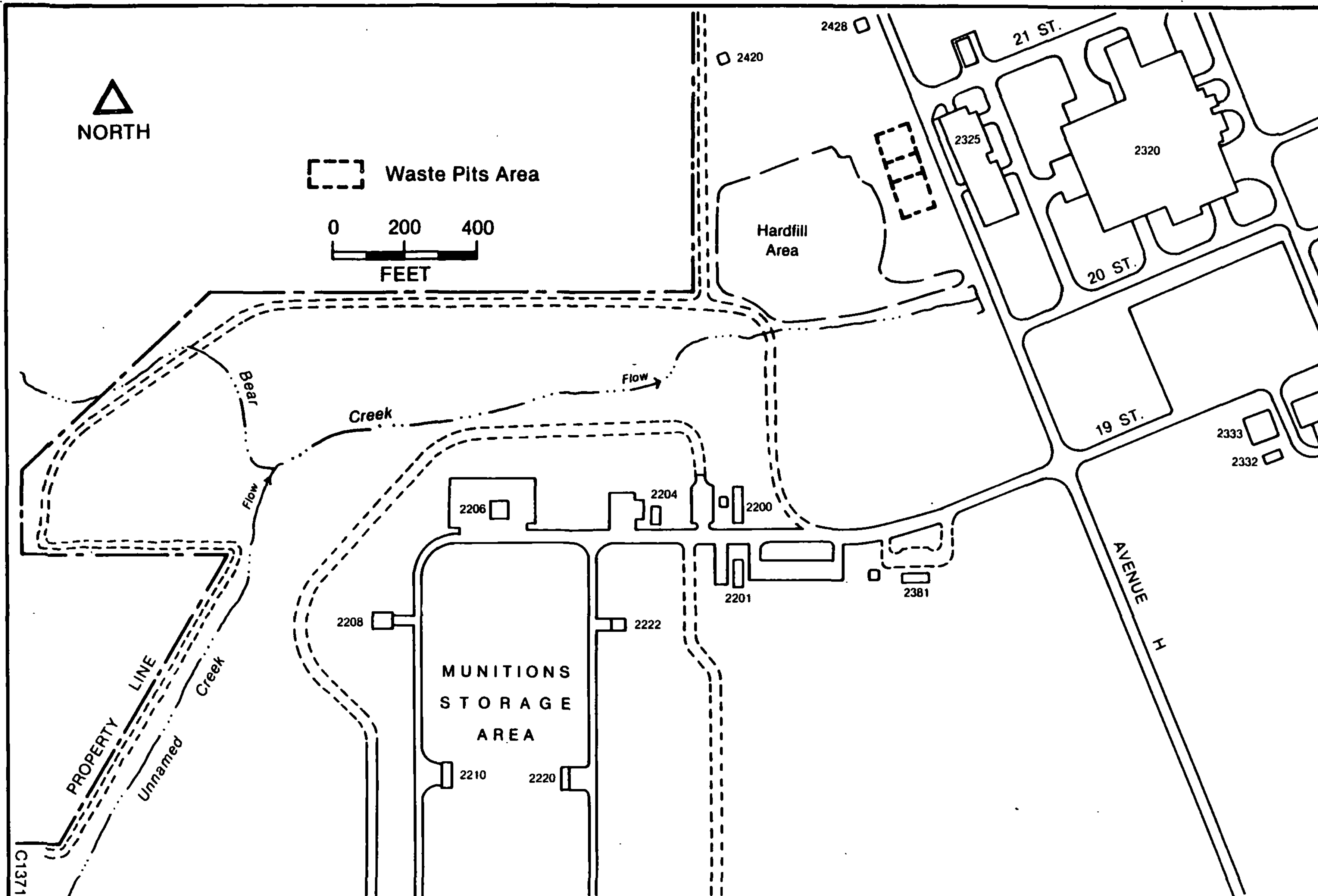


FIGURE 2-11. WASTE PIT LOCATION, SHEPPARD AFB, TX

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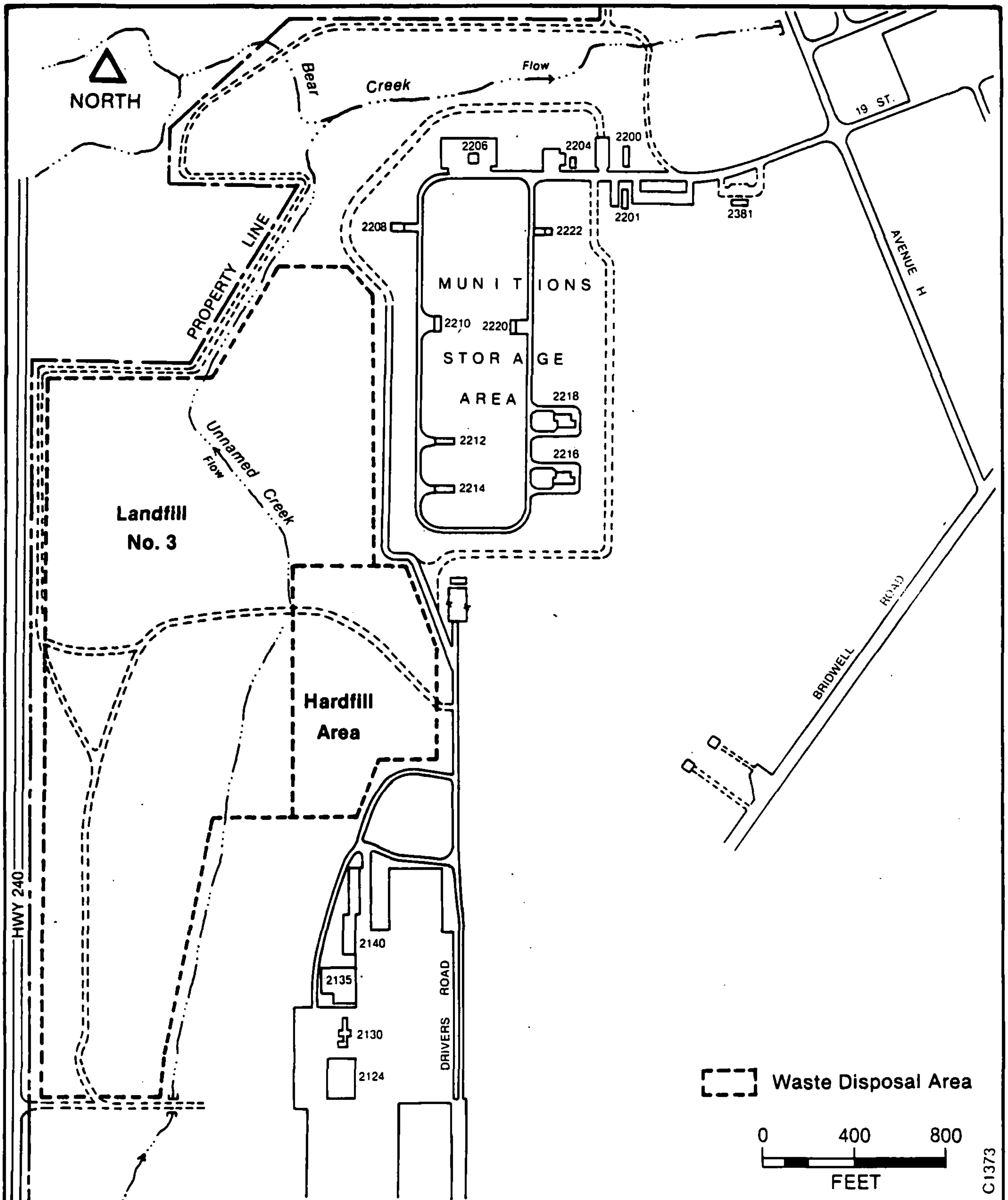

FIGURE 2-12. LANDFILL NO. 3 AND HARDFILL AREA, SHEPPARD AFB, TX

June 1986

in this landfill was primarily normal Base refuse and some waste treatment plant sludge. The operation was performed as trench-and-fill with east-west trenches approximately 14 feet deep. Burning of the refuse occurred until 1968, after which no further burning was performed. The pattern of use was that the landfill was opened first near the Missile Road area, and was progressively opened north to northeast, so that by the early 1970s the area of use was west of the Munitions Storage area. From about 1965 to about 1970, trenches were dug at the north area of the landfill near Munitions Storage, and waste oils were dumped into the trenches along with refuse and covered. Volume estimates ranged from one to seven 55-gallon drums of waste oil per week. A marked low-level radioactive waste burial site is located in the landfill area west of the south end of the Munitions Storage area.

Hardfill Disposal Area

A disposal area for hardfill and other construction rubble has been operated at a site adjacent to Landfill No. 3 and about 800 feet southwest of the southwest corner of the Munitions Storage area (see Figure 2-12). Interviews with Base personnel and examination of aerial photographs indicate that the hardfill disposal site was used beginning in the mid-1960s and continues in limited use at the present time. When first opened, the site was used primarily for normal Base refuse; after the addition of construction rubble from the 1964, tornado damage of the Sheppard Hospital, the site was used as a fill area. As far as can be determined, no waste fuels, solvents or oils were disposed in that area. At the present time, scrap concrete, brush, tree stumps, and scrap metal are visible at the surface of the area. The area slopes downward to an unnamed creek on the northwest side. Sparse vegetation is present on the site. A storage area for bulk construction and paving materials is just southwest of the area.

2.4.3 Fire Protection Training Areas

The Fire Department at Sheppard AFB has operated fire training sites at which fires were ignited and then extinguished. Fire extinguishing agents have included water, AFFF, protein foam, and Halon. Two of the sites in this study are illustrated in Figures 2-13 and 2-14 and are described in the following discussions:

Fire Protection Training Area No. 3 (FPTA No. 3)

FPTA No. 3, located adjacent to the northern corner of the old municipal runway (presently Bridwell Road), was activated in 1957 when FPTA No. 1 was closed for construction of the golf course. This site was in use at the time of this study. The site consists of a storage area containing three 2,000-gallon elevated tanks, a concrete block building for structures fire training, a mock-up of a T-38 used for fire training, and a waste drainage and collection system. The drainage and collection system, installed in 1982, consists of drainage collection and piping leading to an oil-water separator, and a water storage pond. The unburned fuel which drains into the oil-water separator is pumped to the storage tanks for reuse, and the water phase flows to the pond for evaporation. Present burn frequency is approximately quarterly, and about 300 gallons of fuel are consumed per burn (Engineering-Science, 1984). Prior to 1982, no waste collection and separation system was in operation at this site.

Natural soils in the area of FPTA No. 3 are composed of silty loam with relatively low permeabilities. Ground water may occur at less than ten feet below ground. A nearby test boring at Building 2013 encountered clay from 0 to 15 feet below ground (Engineering-Science, 1984).

Visual examination of the area during the site visit indicated only surficial contamination and a fuel odor. Due to the duration and frequency of operations and the lack of a waste oil reclamation facility until recently, a potential for contaminant migration exists for the site (Engineering-Science, 1984).

Within the boundary of FPTA No. 3 and south of the T-38 aircraft mock-up, is a pond used for collection and storage of the aqueous phase of

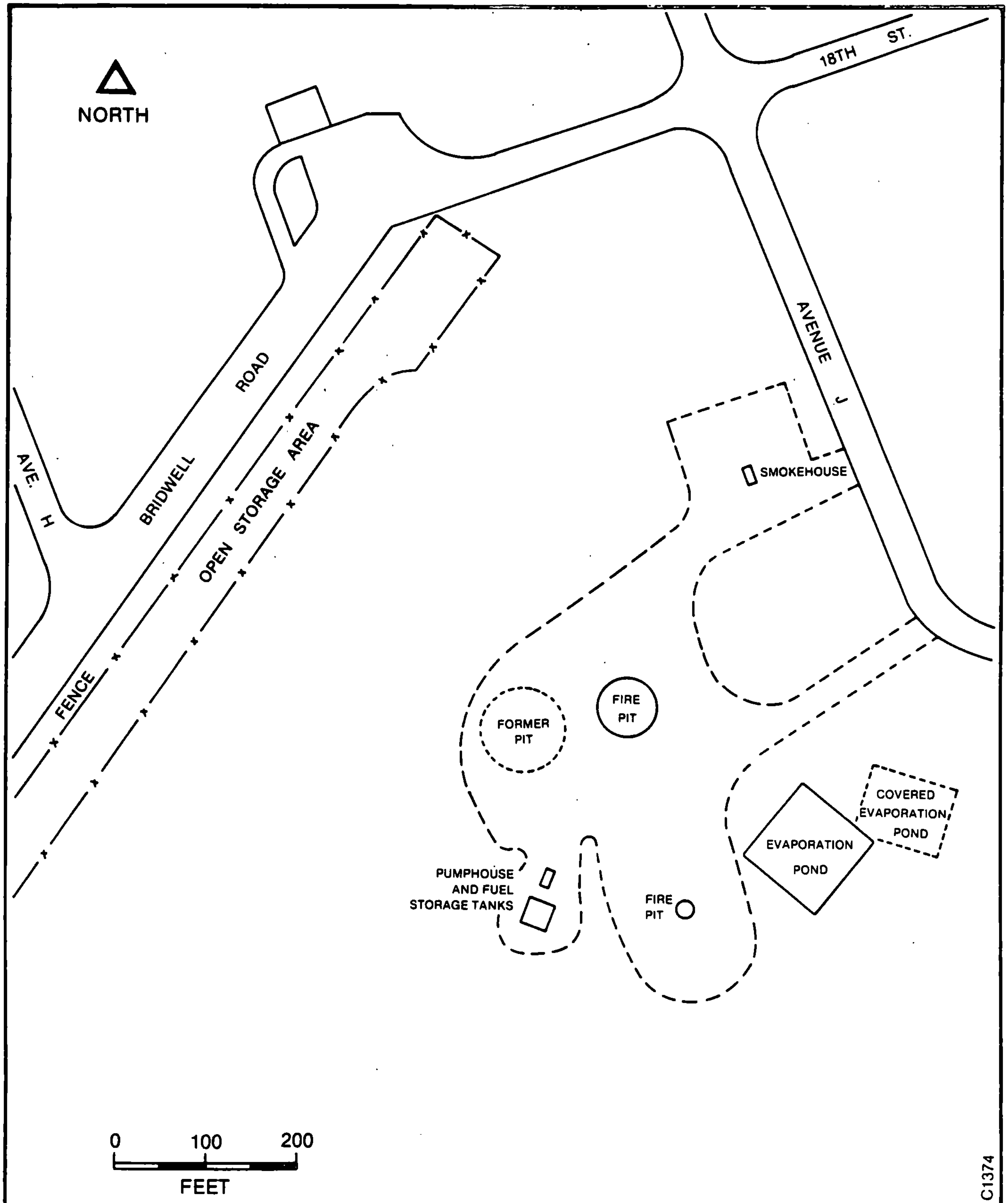

FIGURE 2-13. FIRE PROTECTION TRAINING AREA (FPTA) NO. 3, SHEPPARD AFB, TX

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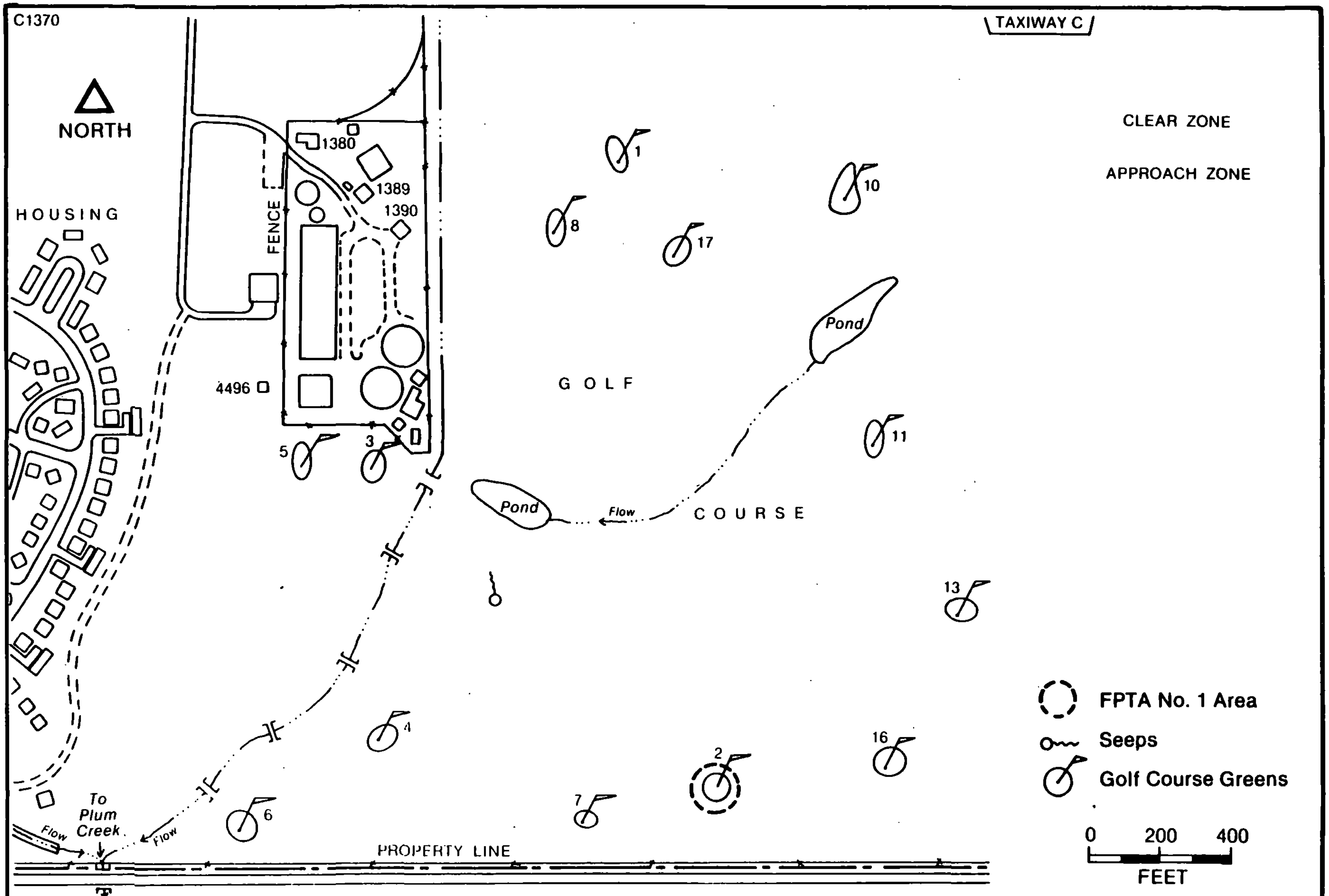

FIGURE 2-14. FIRE PROTECTION TRAINING AREA NO. 1, SHEPPARD AFB, TX

June 1986

drainage from the Fire Protection Training Area. The pond is approximately 60 feet square, of earthen construction. This pond was constructed as part of the refurbishing of the fire protection training area performed during 1981. Inspection at the time of the site visit revealed no hydrocarbon layer on the pond.

Fire Protection Training Area No. 1 (FPTA No. 1)

FPTA No. 1, located adjacent to a landfill which is the present site of the Base golf course (Figure 2-14), was used as a fire protection training area from the 1940s until 1957. The site formerly consisted of a depressed burning area and three old aircraft. A drum storage area north of and adjacent to the site was used to store between 100 and 200 55-gallon drums of contaminated oils, fuels and waste solvents from aircraft maintenance and industrial shop activities. The frequency and duration of burns during the 1940s is unknown. During the 1950s, the drums were transported by flat-bed truck from the drum storage area to the fire protection training site; the drums were drained and burns occurred. During the 1950s, four or five burns occurred each weekend day, and each burn constituted about 400 to 500 gallons of material. As far as can be determined, no drainage collection system was operational at this site.

Visual examination of the area presently reveals no remaining sign that the site was once a fire protection training area. The site is presently filled in and is a part of the Base golf course. Due to the nature and duration of the activity at this site and the relatively shallow depth to ground water, a potential for contaminant migration exists, since much of the unburned material probably seeped into the ground (Engineering-Science, 1984).


3

3.0 FIELD PROGRAM

Various field activities were performed at Sheppard Air Force Base in support of the IRP Phase II (Stage 1) investigation. The activities included geophysical surveys, soil coring, hand augering and monitor well installation. The period of performance of the field activities was 29 October 1984 to 15 February 1985.

3.1 Field Techniques

The following paragraphs describe the various field techniques used in the Sheppard AFB Phase II (Stage 1) investigation.

3.1.1 Geophysical Surveying

Geophysical surveying was performed in order to accurately define the area of investigation at the waste sites. The methods employed include electromagnetics, resistivity surveys and magnetometry, each of which is described below.

Electromagnetics

The geophysical technique selected for the investigation consisted of an electromagnetic survey using two devices: the Geonics EM-31 and the EM-34 ground conductivity sensors. Both ground conductivity sensors are designed for rapidly obtaining data over large areas. The meters employ magnetic dipoles or magnetic induction loops for transmission and reception of low-frequency electromagnetic waves. The effective depth sampled by the EM-31 is 6 meters; the depth sampled by EM-34 depends on coil separation and orientation, applied frequency and to some extent on the conductivity profile of the subsurface. The Earth Technology Corporation of Golden, Colorado, performed the ground conductivity surveys. Operating procedures and specifications of the EM-31 and EM-34 are provided in Appendix L.

The methods of investigation were essentially identical at all sites. Base lines were surveyed at 50 or 100 foot intervals prior to geophysical survey. The base lines were established through the use of previous aerial photographs and data regarding the sites. The grid was surveyed for the waste site locations by compass and measuring chain. The extent of the grids are shown on Figures 3-1 through 3-4. Each point was marked with a labeled pin flag. The measurements made at each station were:

- Measurements made with the EM-31 with vertical magnetic dipoles;
- Measurements made with the EM-34 (10m separation) with horizontal magnetic dipoles; and
- Measurements made with the EM-34 (20m separation) with horizontal magnetic dipoles.

Resistivity Surveys

Resistivity surveys were conducted with a Bison Model 2350 Earth Resistivity meter. The mode of application was by conducting vertical electrical soundings (VES). In performing earth resistivity measurements, a current is injected into the ground by a pair of surface electrodes and a resulting potential field is measured between a second pair of surface electrodes. The subsurface resistivity is then calculated from the applied current, measured voltage, and electrode separation which roughly equates to a depth of investigation. Resistivity is the reciprocal of conductivity, the parameter which is directly measured by the EM technique just described. Interpretation of the resistivity measurements provides information on layering and depths of subsurface horizons as well as lateral changes in the subsurface.

The Bison Model 2350 Earth Resistivity test is utilized for the sounding measurements. Current electrode separations used generally were: 1, 2, 4, 6, 10, 14, 20, 30, 40, and 60 meters. Due to the high and variable

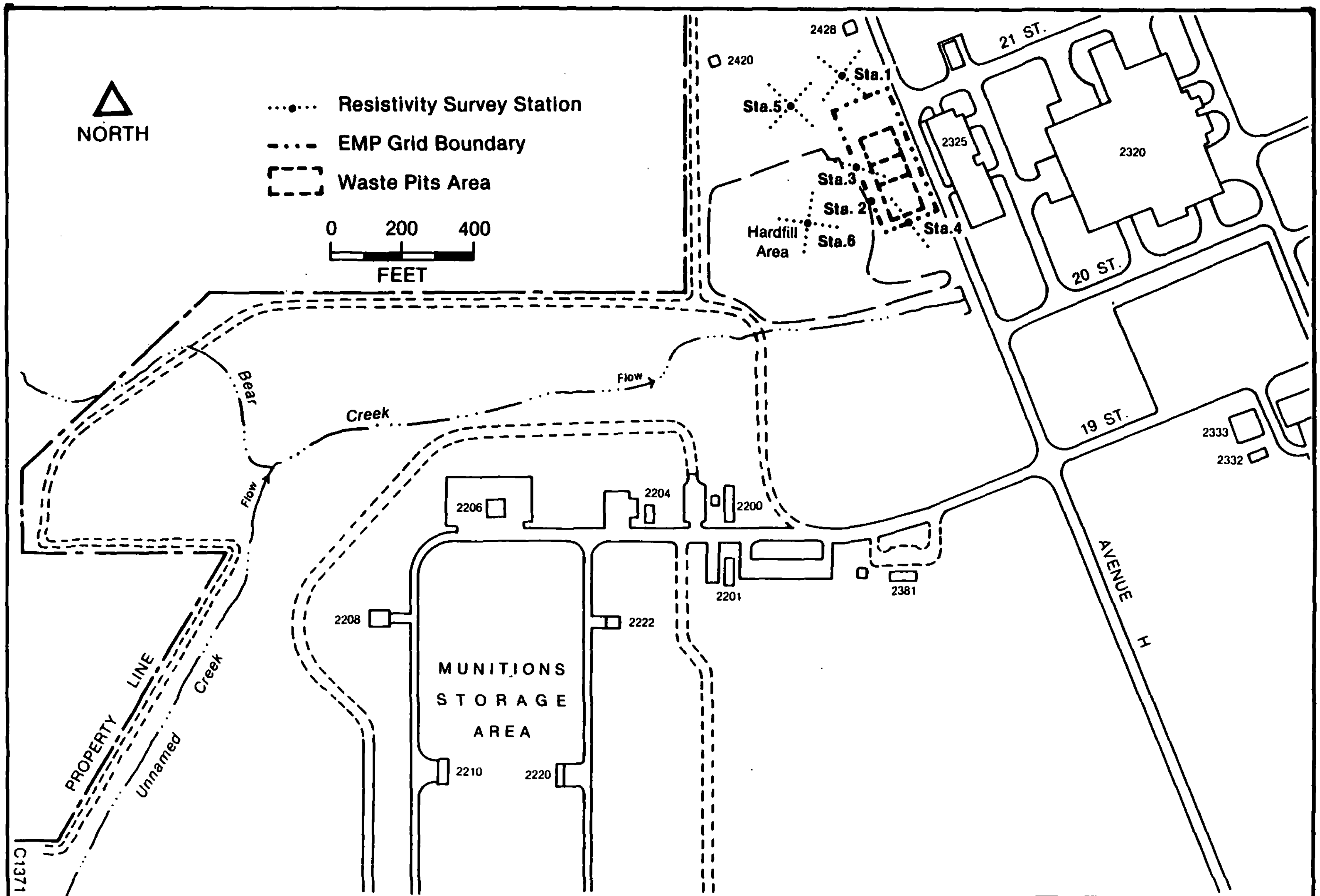

FIGURE 3-1. LOCATION OF GEOPHYSICAL SURVEYS, VICINITY OF WASTE PITS, SHEPPARD AFB, TX

June 1986

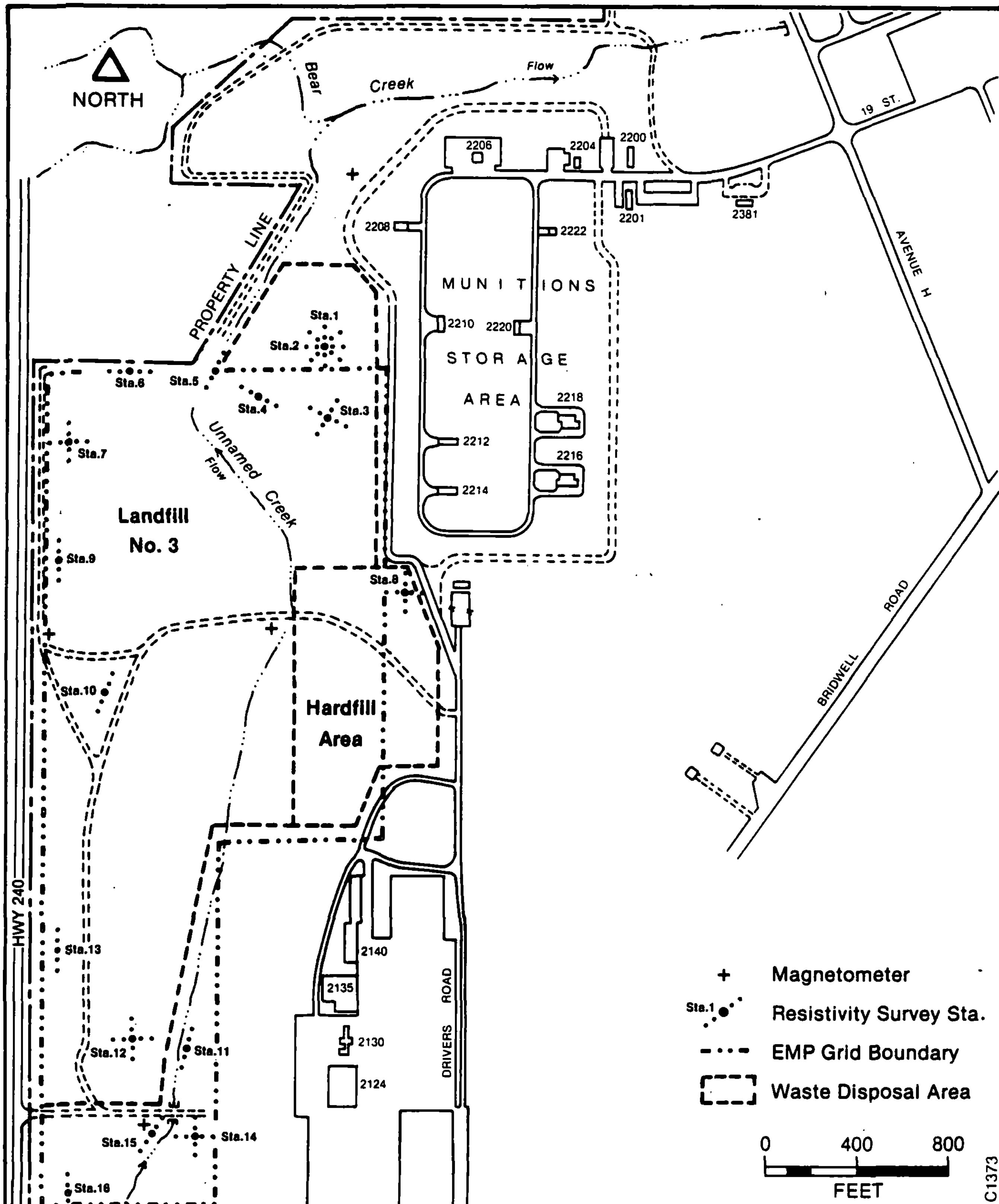

FIGURE 3-2. LOCATION OF GEOPHYSICAL SURVEYS, VICINITY OF LANDFILL NO. 3 AND HARDFILL AREAS, SHEPPARD AFB, TX

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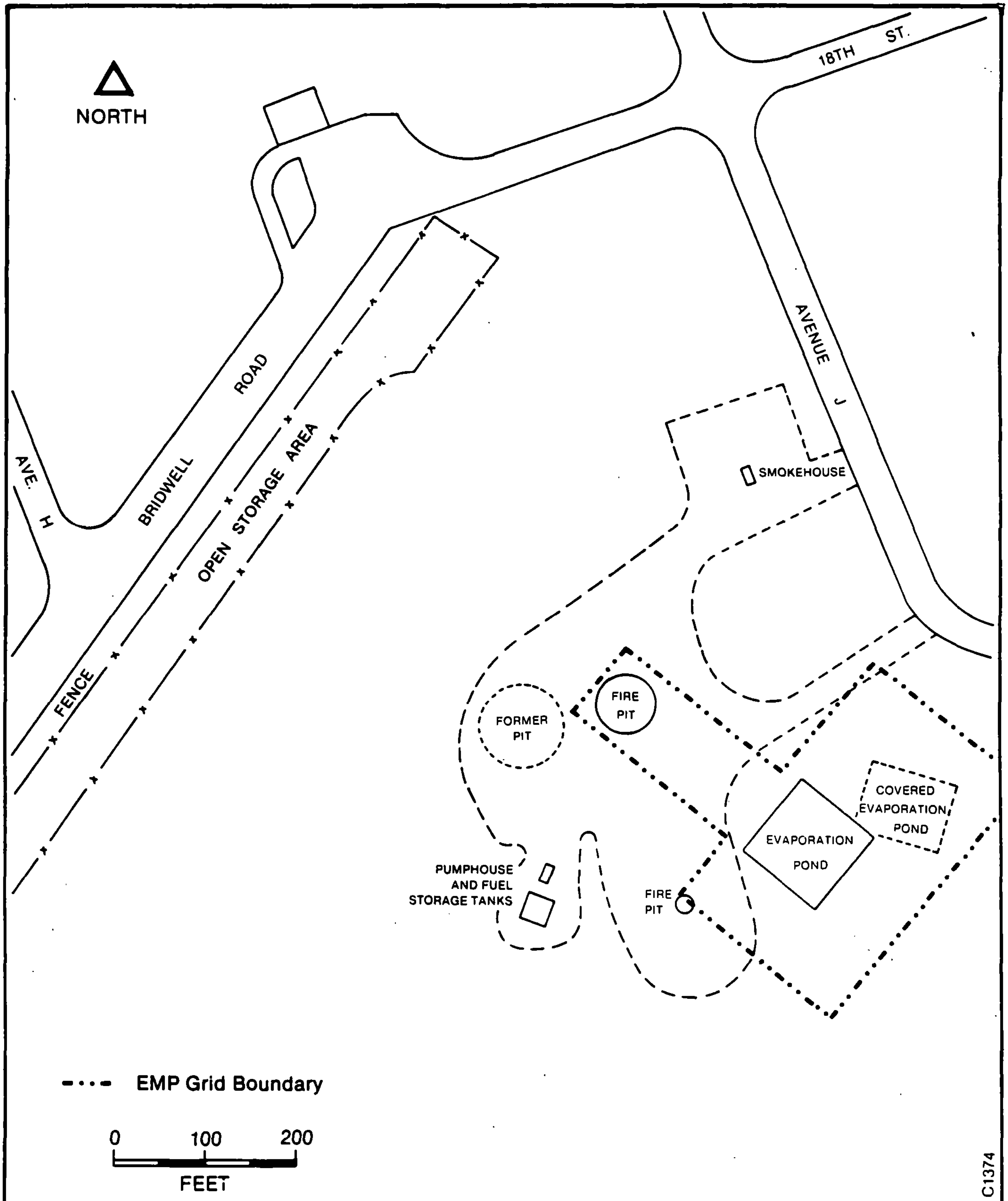

FIGURE 3-3. GENERAL LOCATION OF ELECTROMAGNETIC GRID AT FIRE TRAINING AREA NO. 3, SHEPPARD AFB, TX.

June 1986

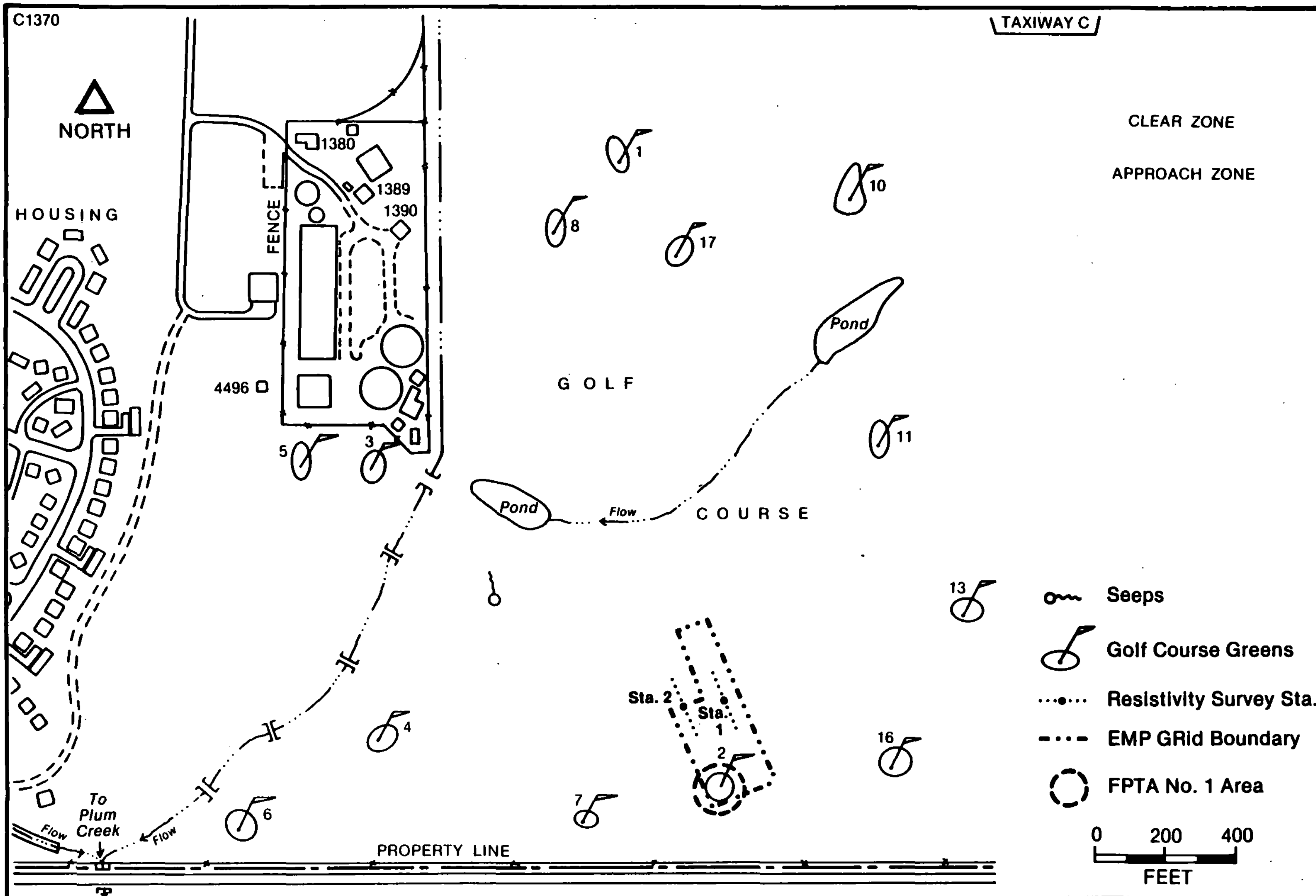

FIGURE 3-4. GENERAL LOCATION OF ELECTROMAGNETIC GRID AND RESISTIVITY SURVEY POINTS, FIRE TRAINING AREA NO. 1, SHEPPARD AFB, TX.

June 1986

ground conductivity, potential electrode separations varied from site to site. The soundings data were processed using an ABEM VES iteration process to obtain a best fit curve. The data were plotted algorithmically as resistivity in ohm-meters versus half the current electrode separation in meters. The plot also includes the layered earth model chosen to create the best fit curve.

Magnetometry

An EDA Model PPM-500 magnetometer was used for magnetic surveying. The purpose was to detect metal objects that could interfere with drilling activities. The magnetic surveys were taken at selected sites which coincided with a corresponding resistivity survey point. The data were obtained in a similar manner as for the electromagnetics. A 50-foot by 50-foot grid was set up with stations every 10 feet and readings taken every five feet. Readings of the total field and magnetic gradient were taken at each location. The units for these readings are gammas and gammas per one-half meter, respectively. Data are plotted in map form and contoured for presentation.

3.1.2 Drilling Techniques

Drilling and coring at Sheppard AFB were accomplished using two techniques: hollow-stem augering for coreholes and monitor wells, and hand augering for shallow soil sampling. Each method was selected on the basis of the anticipated depth of completion, need for detailed control of sampling and water-level observations, and geologic conditions expected at various depths.

Hollow-Stem Augering

Hollow-stem augering was performed with a Mobile B-53 rig. Eight inch diameter bit and auger flights were used to drill the borehole to a depth of 5 feet below the first saturated sample. No drilling fluids or additives were used in the drilling program. As the borehole was advanced, the cuttings discharged at the surface were examined for lithology, moisture and other features to describe the geologic section. Drilling conditions, such as relative rate and ease of penetration, were noted by the driller and recorded by the supervising geologist. Water encountered during drilling was noted with respect to depth of occurrence and rate of production; if needed, drilling was suspended temporarily to allow for recovery of water in the borehole. The decision to complete the borehole as a monitor well was made by Radian's on-site hydrogeologist on the basis of water level (with respect to the predicted regional water level), the likelihood of perched water above a regional water table, and the representativeness of the water table in terms of the impact of the waste disposal site on the quality of ground water.

Existing data regarding the hydrogeological condition at Sheppard AFB were carefully reviewed to determine the most effective well depth. Potential contaminants are often introduced into the ground water by downward migrating infiltration. Once any contaminant reaches the ground water, it is usually dispersed in the water or moves along the top of the saturated zone with the flow except for contaminants such as brine or near-pure streams of industrial chemicals which are denser than water. These contaminants tend to sink or plunge within the ground water system and may travel independently of the ground-water flow direction. Information regarding potential contaminants at Sheppard AFB indicated that there were no brines or pure streams of industrial solvents disposed at the waste sites which would travel below the top of the water table. Wells were therefore completed as near the water table as possible.

Coring

The hollow-stem auger drilling rig was used at the Waste Pits to perform shallow coring through the pits. The hollow-stem method allowed for an accurate examination of soil conditions, identification of waste material and contaminated soil, and recovery of soil samples. The holes were drilled dry; no drilling fluids or additives were used. Samples of soil and any waste were collected with a Shelby tube or split-spoon sampler, a hollow tube driving in advance of the auger at regular intervals (ASTM D-1586). The samples were recovered at the surface, described in terms of lithology and moisture, and retained. Some difficulty was experienced in advancing the augers to the desired depth; the soil was stiff, making for slow penetration and refusal at shallow depth at some locations.

Hand Augering

Hand augering was used at FPTA No. 1 in order to determine if the Fire Protection Training Area was still at its original location and subsequently covered with soil, or if the ground materials comprising the Fire Protection Training Area were bladed or hauled off to another area. The 3-1/2 inch diameter auger was desired because of the shallow depths, 4.0 feet or less, and ease of handling. The cuttings were examined with respect to lithology, moisture, and waste materials which may have been encountered. Samples were then sent to Radian Analytical Services for chemical analyses.

3.1.3 Monitor Well Installations

Ground-water monitor wells were installed upon completion of the drilling operations. Usually, the borehole was observed for a period of time, as necessary, to determine the approximate static water level. Monitor well construction data, summarized in Table 3-1, were consistent with the specifications provided in the Statement of Work. Decisions regarding the setting of screen and casing, length of screen and amount of gravel pack for each well were made on the basis of the observed static water level. If appropriate, the borehole was allowed to remain open overnight; there were some difficulties related to caving in some of the monitor wells.

Monitor well installation followed a similar procedure at each well. Screen and casing sections were cleaned and assembled on the ground then lowered carefully into the borehole. As the string of screen and casing were lowered, additional sections of casing were added until the bottom of the screen reached the complete depth of the borehole. Normally, enough casing was attached so as to leave approximately 4 feet protruding above the ground surface. Clean sand (grain-size analysis in Appendix D) was carefully poured

TABLE 3-1. MONITOR WELL CONSTRUCTION SPECIFICATIONS

- Casing: 2-inch diameter, flush joint, Schedule 80 PVC.
- Screen: 2-inch, flush joint, Schedule 80 PVC, 0.010-inch mill slot. Also, stainless steel screen, same slot and length. Normal screen length was 10 feet reduced to 5 feet at the discretion of the supervising geologist.
- Sand pack: 8-40 mesh silica emplaced from bottom of hole to 2 feet above top of screen.
- Bentonite seal: 2 feet above top of sand pack.
- Grout: neat cement (Type I Portland cement) grout from the top of the bentonite seal to the land surface except where flush completions were desired, in which case grout was poured until 1.5 feet below the land surface.
- Surface completion: the PVC casing was cut off to provide a 2 to 3 foot stickup and solid cap placed on the casing. A 6-inch diameter guard pipe, approximately 4 feet in length, was placed over the exposed casing, and seated in the cement. A locking cap lid was installed on the guard pipe.
- Flush completion: the PVC casing was cut off about 4-6 inches below the land surface and solid cap placed on the coring. A cylindrical locking meter box placed over the wellhead and seated in cement secured the monitor well.
- Guard pipes or posts: 4-inch diameter steel posts, 6 feet in length, with a minimum of 2-feet below ground; 3 each installed radially approximately 4 feet from the wellhead.
- After each well was installed, it was developed by bailing until a clear stream was produced, or until the supervising geologist determined that development was complete.
- The split-spoon and/or Shelby tube sampler was washed between samples (water, acetone, water) and the drill pipe, bit and augers cleaned (pressure water wash) between corings.

down the annular space until the level of the top of the gravel pack was at least 2 feet above the top of the screen, or as directed by the supervising geologist (see individual well completion logs in Appendix D). Bentonite pellets were added to form a 2-foot thick seal, and if necessary for completion activities that occurred above the water table, water from the well was bailed and poured down the annular space to hydrate the bentonite. Neat cement grout was then prepared and tremied from the top of the bentonite seal to the land surface. The grout was allowed to cure for at least 24 hours prior to well development.

The monitor wells were developed by bailing using a five-foot PVC hand bailer suspended by rope. At least three well volumes were removed except in those cases where the well was frequently bailed dry. After completion of the well development program, a protective 6-inch diameter steel casing with lockable lid was cemented into place at the surface, and three steel guard posts were positioned around the well.

3.1.4 Ground-Water Sampling

Ground-water samples were collected for analysis from the nine ground-water monitor wells installed under this program. Field sampling methodologies and equipment are detailed in the following sections.

Water Level Determination

As the first step of ground-water sampling operations at each monitor well, water level measurements were taken using a Soiltest Model 762A electrical probe. The probe and associated electrical line were washed with laboratory deionized water between each well to preclude the possibility of cross-contamination. Measurements were taken to the nearest 0.01 foot with respect to the top of the PVC well casing. The elevation point was surveyed as discussed in Section 3.1.9. Water level measurements taken prior to each sampling operation are listed in Appendix E along other monitor well purging data.

Each well was purged either immediately prior to sample collection or within 2 days of sample collection (for low-yield wells) to ensure that fresh formation and sufficient volume of water was collected for the sample. Purging operations were conducted using 0.35 gallon bottom-discharge PVC bailer. Extremely cold weather and low water producing wells made ground-water sampling difficult. Purging operations were considered complete when 3 wetted well volumes had been evacuated. To prevent cross-contamination, all down-hole equipment used during the purging of the monitor wells was carefully washed with technical grade acetone followed by deionized water.

Specific conductivity and pH were determined in the field using a pH/conductivity meter. Prior to performing a series of pH/conductivity measurements, the instrument was washed with acetone, triple rinsed with deionized water, calibrated against standard solutions of pH units 4.0, 7.0, and 10.0, and then re-washed. The instrument was washed with deionized water between each measurement. Well water temperature measurements were made with a mercury-in-glass thermometer.

Sample Capture

After each well was purged of standing water to ensure representative ground-water characteristics, a sample was collected and split into the analytical aliquots required by the Statement of Work. Samples from wells were collected for the analyses shown in Table 3-2 per the Statement of Work.

The types of containers used for sample collection and the preservation techniques used are summarized in Table 3-3. All aspects of the sampling protocol were conducted in accordance with EPA-approved methods. Field QA/QC measures were employed to ensure that, once collected, sample integrity was maintained during shipping and handling prior to analyses. These QA/QC procedures are discussed in Appendix F.

TABLE 3-2. ANALYTICAL SCHEDULE FOR WATER SAMPLES, SHEPPARD AFB

PARAMETER	WASTE PITS	LANDFILL NO. 3 AND HARDFILL AREA	FPTA NO. 3	FPTA NO. 1
Purgeable Halocarbons (EPA 601)	X	X	X	X
Purgeable Aromatics (EPA 602)	X	X	X	X
Oil and Grease	X	X	X	X
Total Organic Carbon (TOC)	X	X	X	X
pH	X	X	X	X
Total Dissolved Solids (TDS)	X	X	X	X
Metals (Cr, Pb, and Hg)		X	X	
Phenol	X	X		X

TABLE 3-3. SAMPLE COLLECTION SUMMARY

ANALYTICAL PARAMETERS	SAMPLE CONTAINER	PRESERVATION	VOLUME
TDS	Plastic bottle	4°C	500 ml
TOC	Glass bottle	4°C; H_2SO_4 to pH<2	250 ml
Metals	Plastic bottle	HNO_3 to pH<2	500 ml
Volatile organics (EPA 601, 602)	Glass vial with Teflon septa	4°C	40 ml
Phenolics	Glass bottle	4°C; H_2SO_4 to pH<2	1,000 ml
Oil and grease	Wide-mouth glass jar with Teflon-lined lid	4°C; H_2SO_4 to pH<2	750 ml

3.1.5 Geologic Sampling

Geologic sampling consisted of (1) taking grab samples from the cuttings at shallow depths or when distinct changes in lithology were noted, and (2) collection of samples from discrete depths through the hollow stem augers with the use of a split-spoon or shelby tube sampler in accordance with ASTM Method D-1586. All split-spoon or shelby tube samples were described, logged and placed in glass jars with screw-on lids. These samples were labeled and retained by Radian for future reference. Selected samples were frozen and forwarded to Radian Analytical Services for chemical analysis.

3.1.6 Water Sampling Schedule

A total of nine wells were sampled, on two separate sampling rounds, for ground water during Phase II (Stage 1) field activities. The sampling program was performed during February 1985. Generally, sufficient sample was obtained during a single sampling to satisfy the volume requirements for all analytical tests to be performed. However, in some cases, well recovery was very slow, and sample sets from the same sampling point had to be collected on more than one occasion after sufficient time had elapsed for the well to adequately recover. Details of the sampling schedule, including well identification, sample type, date collected, date delivered to the laboratory, and sampler identity are provided in Appendices E and G.

3.1.7 Other Sampling

In addition to the monitor well sampling, selected surface-water samples were also collected. Samples were taken from the evaporation pond at FPTA No. 3, Landfill No. 3, FPTA No. 1 and the Waste Pit area. Samples were submitted for the same chemical analyses as were the ground-water samples.

3.1.8 Field Safety

Before the field work was initiated, a field Safety Plan was prepared specifically for the Sheppard AFB project. This plan, developed from available data, anticipated likely field hazards and prescribed appropriate personal protective equipment for the field team. Drilling, core sampling and monitor well installation within or in close proximity to the waste sites was expected to pose the most significant potential hazards. EPA Level C protection (impervious clothing, gloves, boots, and half-face cartridge respirators) was required for drilling and well installation activities. For the ground-water sampling activities, EPA Level D protection (same as Level C except that respirators were carried, but not worn) was deemed appropriate. The Safety Plan was followed during the complete field effort, and no difficulties were encountered. The complete text of the Safety Plan is presented in Appendix M.

3.1.9 Field Surveying

After all wells were installed, wellhead elevations were determined to the nearest 0.01 foot by surveying from the nearest benchmark. Corlett, Probst, and Boyd, Inc., a consulting engineer and surveying firm from Wichita Falls, Texas accomplished this survey work.

3.2 Site Activities

The field program at Sheppard AFB consisted primarily of the installation and sampling of ground-water monitor wells. Other activities, such as geophysical surveying, soil coring and sampling, and creek and pond sampling, were also conducted. The conduct of the field program is presented in narrative form in the following subsections. Each site that was investigated (Figure 3-5) is discussed separately, below:

3.2.1 Waste Pits

This section contains a description of the field activities conducted at the waste pits. The waste pits (Figure 2-11) are located at the northern side of Sheppard AFB. Bear Creek flows by the southside of the waste pits. Radian's activities at the waste pits included geophysical surveys, drilling and sampling of 5 coreholes, and surface water sampling from nearby Bear Creek.

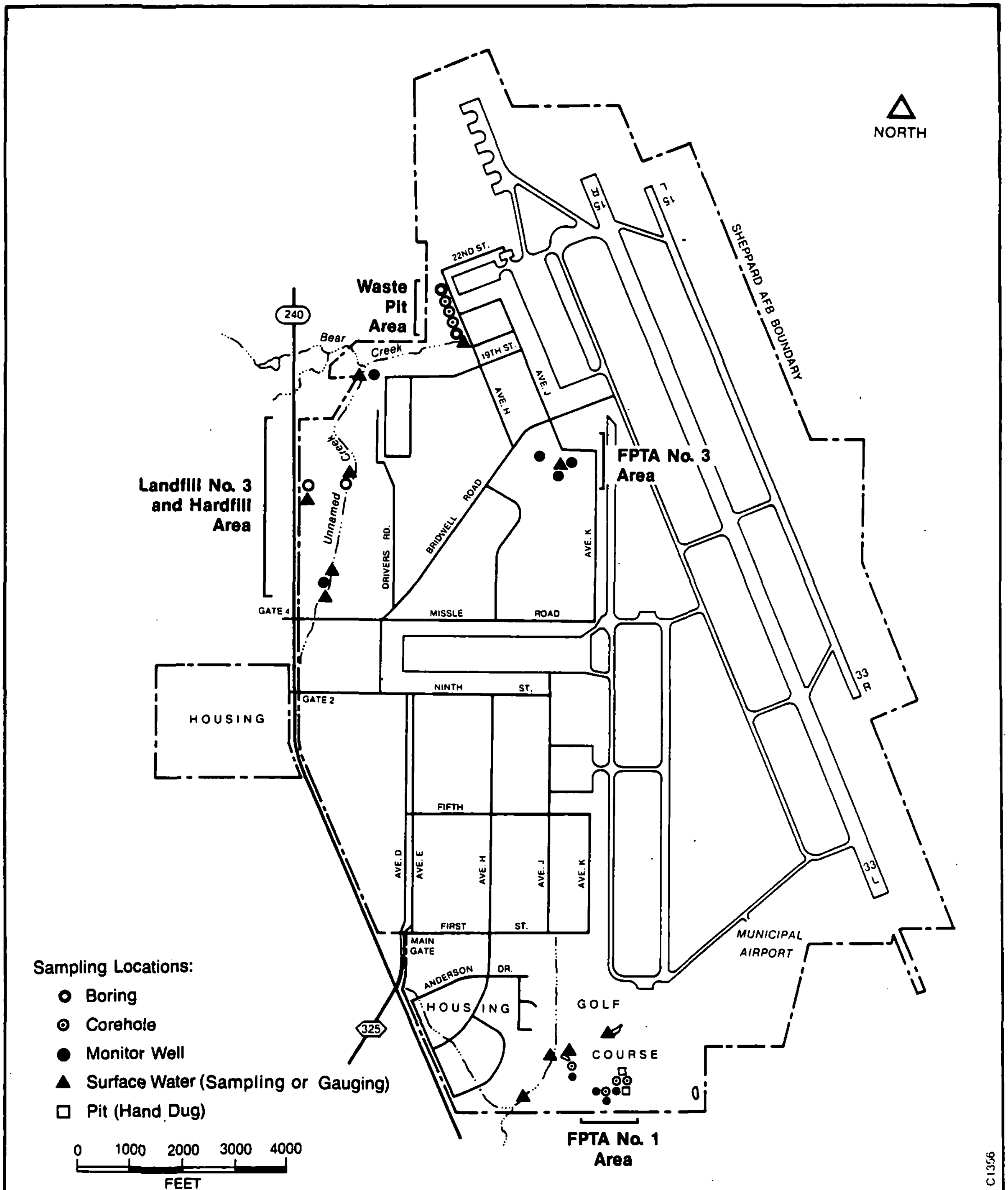

FIGURE 3-5. LOCATIONS OF IRP STUDY SITES, SHEPPARD AFB, TX

June 1986

Geophysical Surveys

Two geophysical surveys were conducted. The first survey was performed using electromagnetics (EM) to aid in waste pit location and contamination migration. A field grid of 140 feet by 300 feet was essentially centered on the waste pits. Station points were located every twenty feet within the grid and around the perimeter. EM-31 and EM-34 instrumentation was used. The second survey was performed with a resistivity meter to obtain soundings at six locations about the site. This survey was used to obtain geologic information and screen locations for prospective monitor wells.

The EM survey area and the six resistivity survey locations are illustrated on Figure 3-1. Details of the procedures and equipment used in the survey were discussed in Section 3.1.1.

Coring Activities

The locations of the corehole drilling sites are illustrated on Figure 3-6. One corehole, drilled to 30 feet, was emplaced in each pit. These coreholes were designated as C-1, C-2, and C-3. Soil samples were collected and analyzed for the parameters shown in Table 3-4. The coreholes were evaluated in order to provide data on the status of the waste pits and to determine if contaminant migration had occurred. One corehole was left unplugged for four weeks to determine if ground water or leachate would collect in the boring. At the end of four weeks, no ground water or leachate was observed.

Three monitor well locations were selected at the waste pits. Borings were made at locations B-1 and B-3 (Figure 3-6), but did not encounter ground water. The Radian on-site geologist recommended to the OEHL Technical Monitor that the two borings be plugged with grout and that the third monitor well not be attempted. The OEHL Technical Monitor concurred; therefore, the third monitor well was not attempted. Boring-specific data is provided in Table 3-5 and Appendix D.

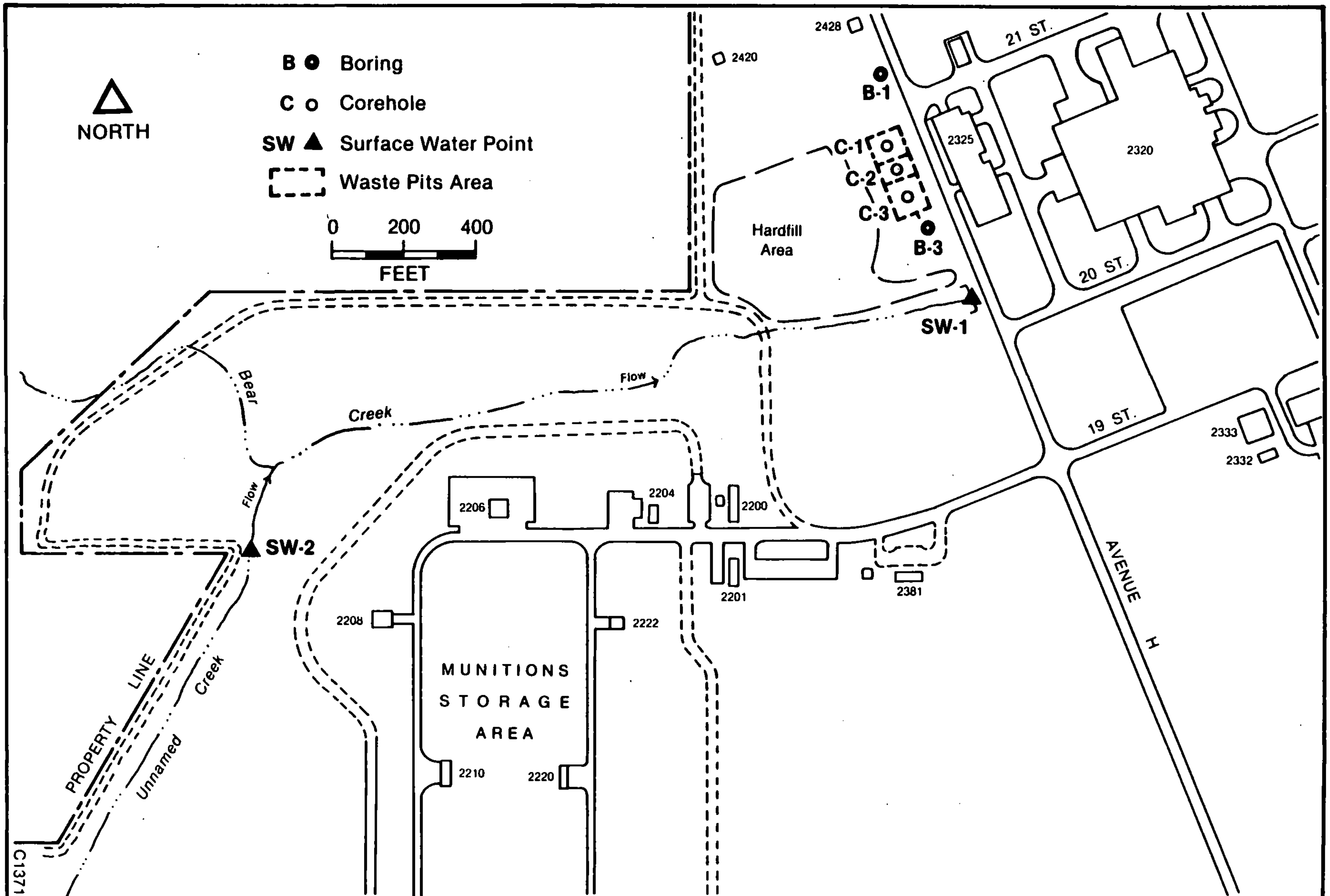

FIGURE 3-6. LOCATIONS OF COREHOLES AND SURFACE WATER SAMPLING POINTS, VICINITY OF WASTE PITS, SHEPPARD AFB, TX

June 1986

TABLE 3-4. LIST OF ANALYTICAL PARAMETERS FOR SHEPPARD AFB IRP PHASE II STAGE 1 INVESTIGATION

LIST	PARAMETER
A	Purgeable Halocarbons and Aromatics Phenol Total Organic Carbon Oil and Grease Total Dissolved Solids* pH
B	Purgeable Halocarbons and Aromatics Total Organic Carbon Oil and Grease Total Dissolved Solids* pH Lead Chromium Mercury

*Omitted for soils analyses.

TABLE 3-5. WASTE PITS CORE AND BOREHOLE DATA

CORE OR BOREHOLE NUMBER	GROUND LEVEL ELEVATION[1]	DEPTH OF CORE BOREHOLE[2]	DEPTH ELEVATION[3]
B-1	997	45	952
B-3	980	40	940
C-1	984	30	954
C-2	983	30	953
C-3	982	30	952

[1]Feet are approximated from a Base topographic map.

[2]Feet below ground level.

[3]Feet, msl.

Other Sampling

In addition to corehole sampling, surface water samples were collected for chemical analyses. Refer to Figure 3-6 for location of the surface water sample sites, labeled SW-1 and SW-2.

3.2.2 Landfill No. 3 and Hardfill Areas

Landfill No. 3 and the hardfill area, comprising about 60 acres on the northwest corner of the Base, were used for Base refuse and hardfill from 1957 to 1972. One unnamed tributary to Bear Creek flows through the site. The IRP Phase II (Stage 1) activities that took place at this site included geophysical surveys, drilling and completion of two monitor wells and two boreholes, and ground-water and surface-water sampling at six locations.

Geophysical Surveys

Electromagnetics, resistivity and magnetometry surveys were conducted at Landfill No. 3. The EM survey was used to define the waste site and detect potential contamination migration, while the resistivity and magnetometry surveys were used to screen potential sites for monitor well installation.

The EM survey was conducted over a grid of 1,500 feet by 3,600 feet. The grid was centered on the site. A swampy, brushy area and the Base firing range were not included due to safety and efficiency considerations. EM readings were done every 50 feet about the grid. The area of the EM grid is shown on Figure 3-2.

Fifteen sites were screened for potential monitor well installation using resistivity soundings. After resistivity data were analyzed in conjunction with field observations, four of the survey sites were selected for magnetometry surveying.

The magnetometry surveys shown on Figure 3-2 consisted of a 50 feet by 50 feet grid surrounding the resistivity survey point. Magnetic readings were taken every five feet. The magnetometry survey was used to insure that no large metal objects were underground which could interfere with the drilling.

Monitor Well Installation

Drilling for the emplacement of monitor wells at the landfill area was conducted during the period of 13 November 1984 to 29 January 1985. Rains and inclement winter weather curtailed the drilling operations on several occasions. Locations B-5, B-6, and MW-7 (Figure 3-7) were drilled into essentially clay formations. Each incomplete hole was allowed to stand, permitting the collection of any ground water. A ground-water seep was found in MW-7, and a monitor well installed. Borings B-5 and B-6 were dry and subsequently grouted. The last location drilled was MW-4, where ground water was encountered, and a monitor well installed. Since no obvious contamination was found, it was decided after technical monitor approval to complete the monitor wells entirely with PVC casing and screen in lieu of more costly stainless steel screen, where the production of water was unlikely. Additionally, MW-7 was completed with a filter cloth due to the very fine silts and clay particles in the borehole that could plug the screen or pass through to fill up the PVC casing if suspended in the water.

Appendix D contains the boring logs and monitor well completion data. Table 3-6 provides a summary of the borehole and monitor well data.

Monitor Well Sampling

After the completion and initial development of the monitor wells, each one was purged and sampled. Field sampling was conducted by Radian personnel during the period 7 through 15 February 1985. Details of the field sampling procedures are presented in Section 3.1.4. The ground-water samples were analyzed for the parameters specified in the Statement of Work as shown on Table 3-2. Results of all analyses are discussed in Section 4.3.1.

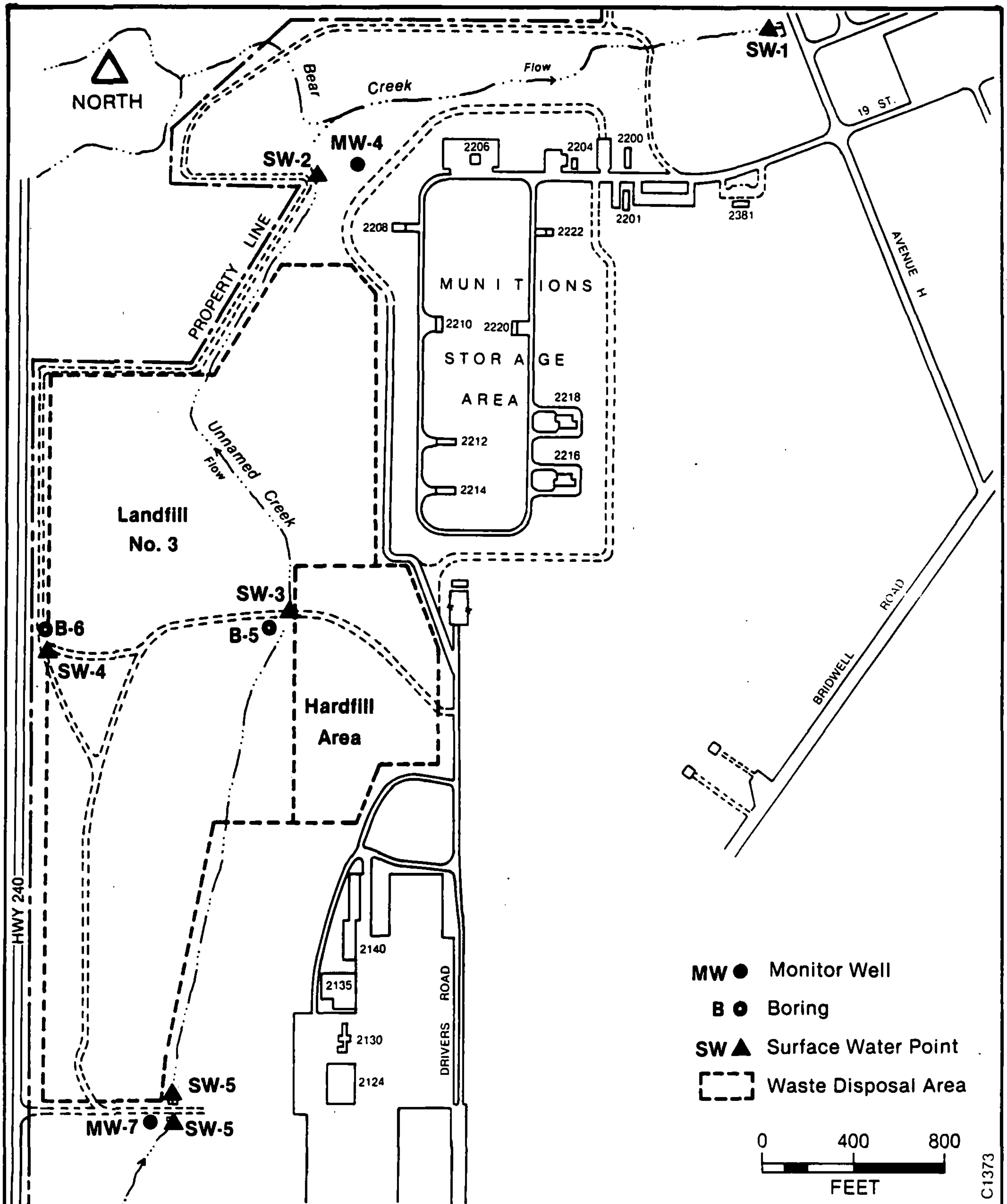

FIGURE 3-7. LOCATIONS OF BORINGS, MONITOR WELLS, AND SURFACE WATER POINTS, VICINITY OF LANDFILL NO. 3 AND HARDFILL AREAS.

June 1986

TABLE 3-6. LANDFILL NO. 3 AND HARDFILL AREA BOREHOLE, MONITOR WELL AND SURFACE WATER CONTROL POINT DATA

LOCATION	MEASURING POINT ELEVATION[1,2]	MEASURING POINT HEIGHT (ft)	GROUND LEVEL ELEVATION[2]	SCREENED INTERVAL[3]	SCREEN ELEVATIONS[4]	TOTAL DEPTH[5]	DEPTH ELEVATION[4]
B-5	NA[6]	NA	(apx)[7] 1,005.0	NA	NA	51.0	(apx) 954.0
B-6	NA	NA	(apx) 1,008.0	NA	NA	40.0	(apx) 968.0
MW-4	994.81	+2.8	992.01	10.0 - 20.0	982.01 - 972.01	20.0	972.01
MW-7	1,029.81	2.8	1,027.01	15.0 - 40.0	1,012.01 - 987.01	40.0	987.01
SW-2	991.96	NA	992.0	NA	NA	NA	NA
SW-5	1,025.55	NA	1,025.6	NA	NA	NA	NA

[1] Surveyed top of PVC casing for monitor wells; to nearest 0.01 foot.

[2] Feet, msl; taken from Base topographic map for borings B-5 and B-6.

[3] Feet below ground level.

[4] Feet, msl.

[5] Feet below ground level.

[6] NA = not applicable.

[7] (apx) = approximate.

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Other Sampling

Two surface water locations were sampled during the monitor well sampling. Sample locations are shown on Figure 3-7 as SW-2 and SW-5. The samples were analyzed for the same parameters as the monitor wells. The resulting control data are presented on Table 3-6. Two other surface water points (SW-3 and SW-4) were used for water elevation measurements using a steel tape.

3.2.3 Fire Protection Training Area (FPTA) No. 3

FPTA No. 3, located adjacent to the northern corner of the old municipal runway (now Bridwell Road), was activated in 1957 when FPTA No. 1 was closed to provide for construction of the golf course. The site is actively used at the present time. The drainage and collection systems, installed in 1982, consist of drainage collection and piping leading to an oil-water separator and an unlined water storage pond. Prior to 1982, no waste collection or separation system was in operation at this site.

Geophysical Survey

Electromagnetics was used to detect and locate, to the extent possible, any contaminant migration due to the FPTA No. 3 activities. Two initial grids were set up about the site. The northern section (Figure 3-3) encompassed the active training pit and the area toward the evaporation pond. The southern section centers on the active evaporation pond. The dimensions of these sections are 100 feet by 200 feet, and 300 feet by 200 feet, respectively. EM-34 readings were taken every 20 feet on the northern section and for the southern section, at 20 foot intervals along 40 foot lines.

Supplemental geophysical EM-34 readings were taken in selected areas where additional depth information was desired. An attempt was made to take EM-31 readings to screen the old fire training pit, but due to uncertain readings, no detailed grid was constructed. The readings were ambiguous, probably due to numerous buried pipes and metal objects.

Monitor Well Installation

Drilling for the emplacement of monitor wells at FPTA No. 3 was conducted during the period of 16 November 1984 to 30 January 1985. Three monitor wells (MW-8, MW-9 and MW-10) were installed. The locations are shown on Figure 3-8. Appendix D contains boring logs and monitor well completion data. Table 3-7 provides a summary of the borehole and monitor well data.

Monitor Well Sampling

After the completion and initial development of the monitor wells, each one was purged and sampled for each of two rounds of sampling. The two separate field sampling rounds were conducted by Radian personnel during the period 7 through 15 February 1985. Details of the field sampling procedures are presented in Section 3.1.4. The ground-water samples were analyzed for the parameters specified in the Statement of Work as shown on Table 3-2. Results of all analyses are discussed in Section 4.4.1.

Other Sampling

Water samples were collected from the evaporation pond during the two rounds of monitor well sampling. The evaporation pond sampling location is shown on Figure 3-8 as SW-6. A composite grab sample of drill cuttings from MW-9 was also obtained for EP toxicity and ignitability testing. Field observations at MW-9 noted hydrocarbon odors when sampled. This was verified by sampling the air with a Draeger polytest organic vapor indicator.

3.2.4 Fire Protection Training Area (FPTA) No. 1

FPTA No. 1, located at the Base golf course, was used as a fire protection training area from the 1940s until 1957. The site consisted of a depressed burn area and three old aircraft. The frequency and duration of the burns during the 1940s is unknown. During the 1950s, about five burns occurred each weekend day with each burn consuming about 400 to 500 gallons of

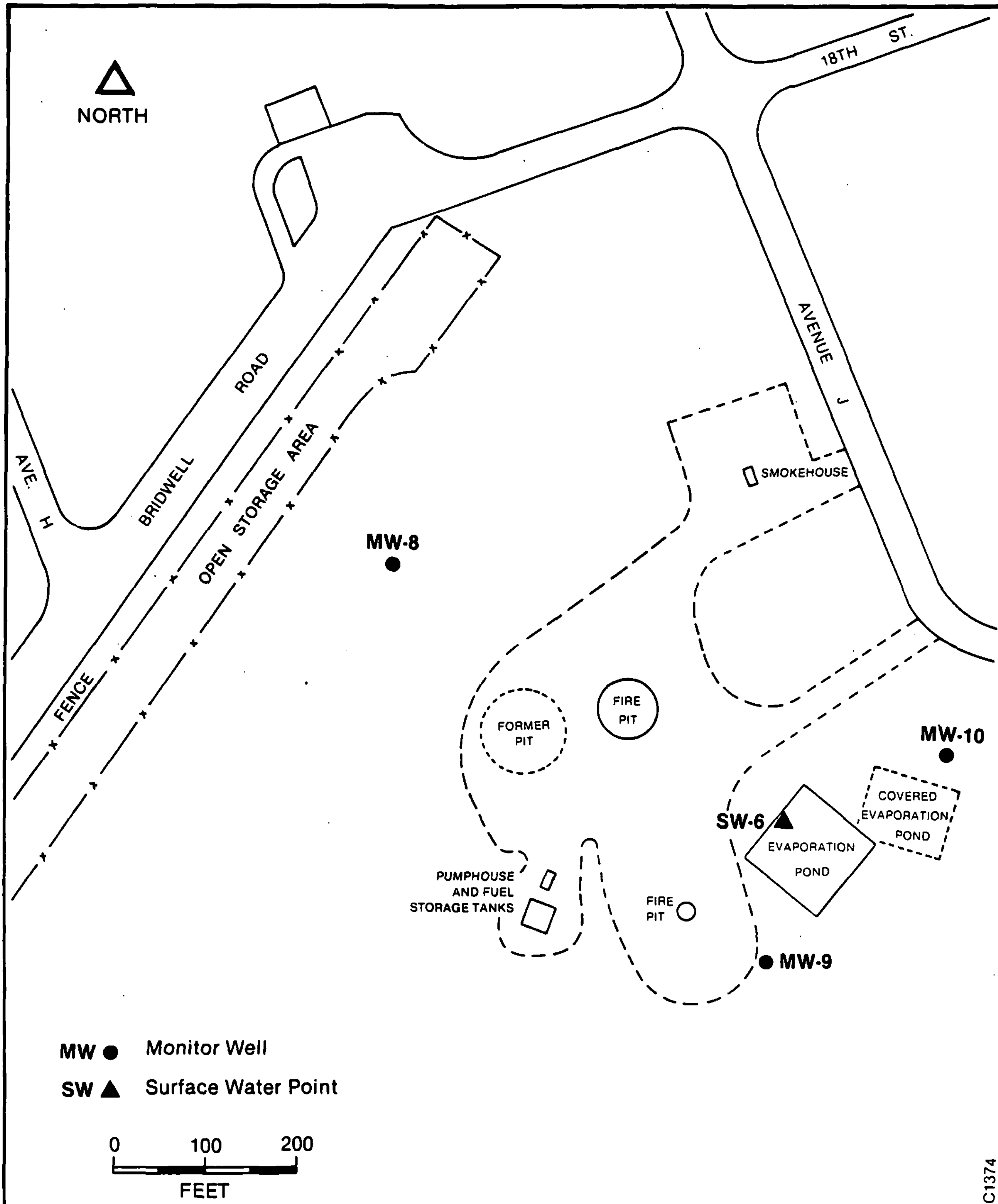

FIGURE 3-8. LOCATIONS OF MONITOR WELLS AND SURFACE WATER POINT VICINITY OF FPTA NO. 3, SHEPPARD AFB, TX.

June 1986

TABLE 3-7. FIRE PROTECTION TRAINING AREA NO. 3 MONITOR WELL AND SURFACE WATER CONTROL POINT DATA

BOREHOLE/MONITOR WELL OR SURFACE WATER	MEASURING POINT ELEVATION[1]	MEASURING POINT HEIGHT	GROUND LEVEL ELEVATION	SCREENED INTERVAL[2]	SCREEN ELEVATIONS[3]	TOTAL DEPTH[4]	DEPTH ELEVATION[5]
SW-6	992.0	NA	992.0	NA	NA	NA	NA
MW-8	1,001.34	2.8	998.54	20.0 - 30.0	978.54 - 968.54	30.0	968.54
MW-9	995.86	2.7	993.16	25.0 - 35.0	968.16 - 958.16	35.0	958.16
MW-10	995.45	3.0	992.45	20.0 - 30.0	972.45 - 962.45	30.0	962.45

[1] Surveyed top of PVC casing for monitor wells; to nearest 0.01 foot.

[2] Feet below ground level.

[3] Feet, msl.

[4] Feet below ground level.

[5] NA = not applicable.

flammable material. As far as can be determined, no drainage collection system was operational at this site. The site is presently well graded as part of the Base golf course.

Geophysical Survey

The purpose of the electromagnetics survey was to detect and locate any contaminant migration due to past FPTA No. 1 activities. Positions of the grid were extended 500 feet beyond the planned limits of the grid in order to obtain closure of an anomalous zone. EM reading stations were located every 25 feet within the grid.

It had been reported that a sandstone layer existed below the site. Therefore, two reconnaissance resistivity soundings were made in order to screen the subsurface to detect the sandstone and to see if the method could be applied at the site. Soil and topographic variability did not permit accurate depth estimates and therefore, detailed sounding was not used at the site.

Monitor Well Installation

Drilling for the emplacement of four monitor wells at FPTA No. 1 was conducted during the period of 16 November 1984 to 30 November 1984. The monitor well installations are depicted on Figure 3-9 as MW-11, MW-12, MW-13, and MW-14. Appendix D contains boring logs and monitor well completion data. Table 3-8 provides a summary of the monitor well data.

Monitor Well Sampling

After the completion and initial development of the monitor wells, each one was purged and sampled. Two field samplings were conducted by Radian personnel during the period 2 February 1985 to 13 February 1985. Details of the field sampling procedures are presented in Section 3.1.4. The ground-water samples were analyzed for parameters specified in the Statement of Work

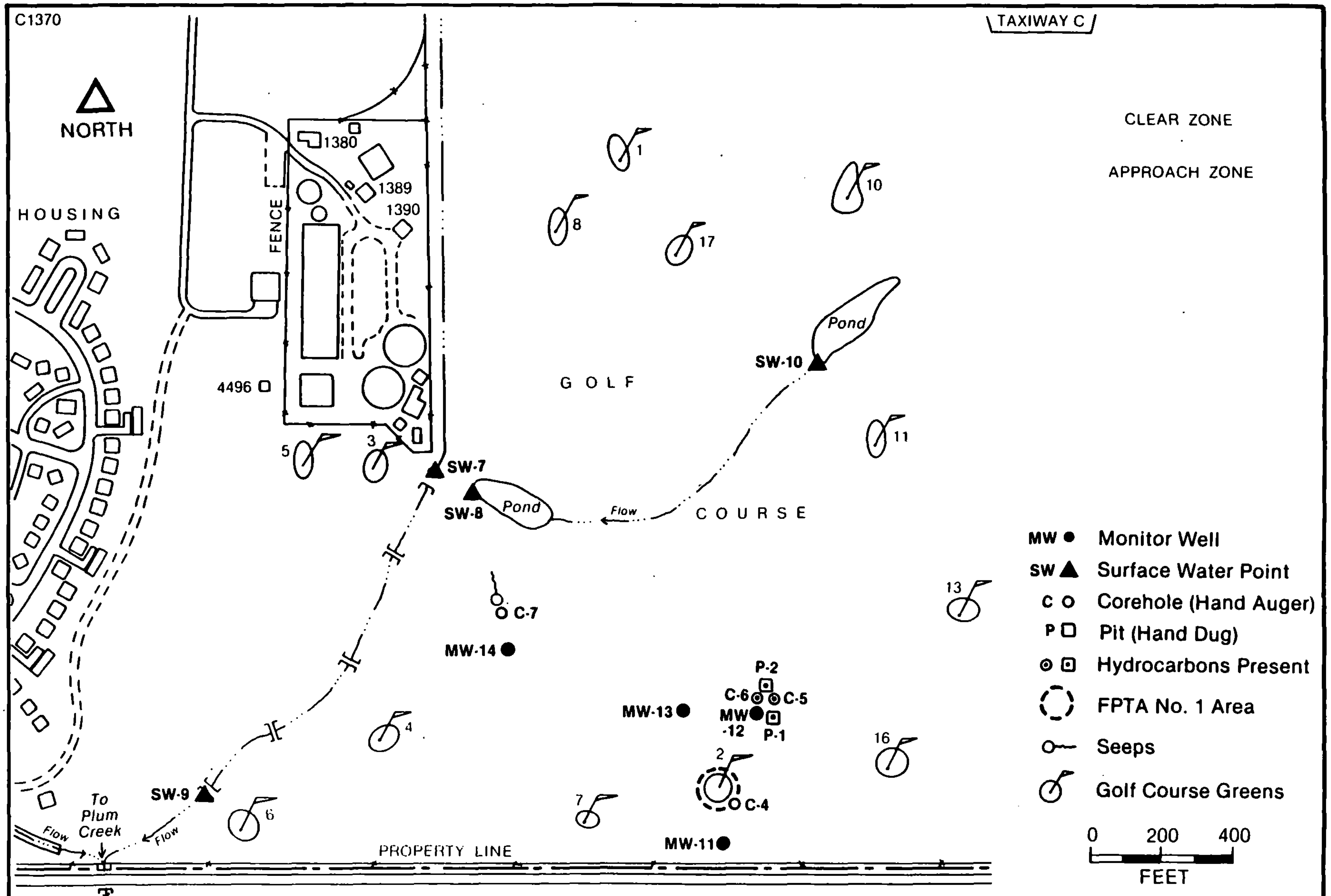

FIGURE 3-9. LOCATIONS OF MONITOR WELLS, SURFACE WATER POINTS AND COREHOLES, VICINITY FPTA NO. 1, SHEPPARD AFB, TX.

June 1986

TABLE 3-8. FIRE PROTECTION TRAINING AREA NO. 1 MONITOR WELL AND SURFACE WATER CONTROL POINT DATA

BOREHOLE/MONITOR WELL OR SURFACE WATER	MEASURING POINT ELEVATION[1]	MEASURING POINT HEIGHT	GROUND LEVEL ELEVATION	SCREENED INTERVAL[2]	SCREEN ELEVATIONS[3]	TOTAL DEPTH[4]	DEPTH ELEVATION[5]
SW-7	997.91	NA	997.9	NA	NA	NA	NA
SW-8	982.69	NA	982.7	NA	NA	NA	NA
SW-9	974.06	NA	974.1	NA	NA	NA	NA
MW-11	1,016.27	-0.6	1,016.87	19.4 - 29.4	997.47 - 987.47	30.0	986.87
MW-12	1,007.59	-0.2	1,007.79	15.0 - 25.0	992.79 - 982.79	25.0	982.79
MW-13	1,009.42	-0.4	1,009.82	10.0 - 20.0	999.82 - 989.82	20.0	989.82
MW-14	998.17	-0.3	998.47	9.6 - 19.6	988.87 - 978.87	19.6	978.87

[1]Surveyed top of PVC casing for monitor wells; to nearest 0.01 foot.

[2]Feet below ground level.

[3]Feet, msl.

[4]Feet below ground level.

[5]NA = not applicable.

as shown on Table 3-2. Results of the analyses are discussed in Section 4.5.1.

Surface Water Sampling

Surface water samples were collected during monitor well sampling activities. Three locations (SW-7, SW-8, and SW-9) were sampled for field and chemical analyses and surface water elevations were determined (SW-10). Field analyses were conducted at one other location. Elevations of the surface water control points are shown on Table 3-8, while the locations of the points are shown on Figure 3-9. The analytical parameters were the same as for the monitor wells noted on Table 3-2.

Other Sampling

Soil samples were collected by hand augering at four locations about the site. The locations of these core holes are shown on Figure 3-9. Two samples were obtained for EP toxicity and ignitability analyses. The results of the core sampling are discussed in Section 4.5.1.

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4

4.0 DISCUSSION OF RESULTS AND SIGNIFICANCE OF FINDINGS

This section presents the major findings of this investigation and their significance as they relate to regulatory standards and human health criteria. Each site is also discussed separately with respect to the results of the geologic, hydrologic and analytical data obtained during the Phase II (Stage 1) investigation. The results of the investigations at each site are presented in terms of the work performed, site topography and geology, followed by detailed descriptions of the hydrology, and ground-water and surface water chemistry. Analytical data are discussed within the context of current regulatory standards and criteria. As appropriate, references are made to Base-wide trends or features common to more than one site. A discussion of the significance of the findings follows the presentation of the results. The sites of investigation are shown on Figure 4-1 and consist of the Waste Pits, Landfill No. 3 and Hardfill Areas, and Fire Protection Training Areas (FPTA) Nos. 3 and 1.

4.1 Regulatory Standards and Human Health Criteria

In order to determine possible water quality impacts on the local ground-water systems, the organic and inorganic compounds detected in the ground-water samples were compared to various criteria. These criteria were drawn from Federal and Texas State drinking water regulations, standards and guidelines. Table 4-1 lists the regulatory standards, both primary and secondary, for selected inorganic parameters. These standards provide a stringent comparison for human health considerations.

Human health criteria are also available for most of the organic compounds and inorganic elements observed in samples collected during this study. The human health criteria are summarized on Table 4-2. Although these criteria do not have the force of standards, they do provide a valid means of assessing the implications of the compounds in question. Many of the compounds are proven or suspected animal carcinogens, therefore, zero consumption is recommended for the protection of human health. Many are also regulated as hazardous waste under RCRA (40 CFR Parts 262 and 263). For each site, the

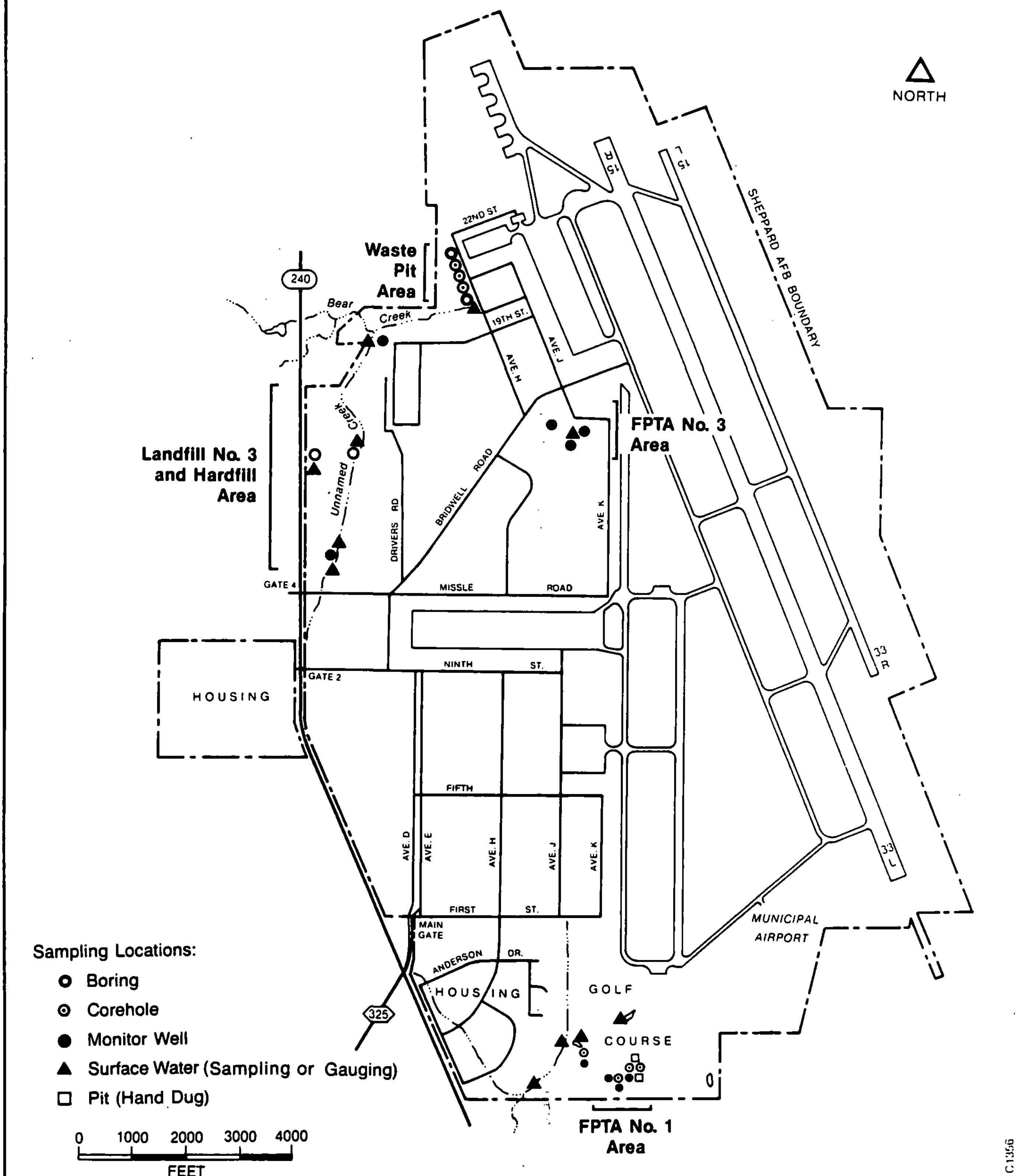

FIGURE 4-1. LOCATIONS OF IRP STUDY SITES, SHEPPARD AFB, TX

June 1986

TABLE 4-1. REGULATORY STANDARDS OR GUIDELINES FOR ORGANIC COMPOUNDS AND INORGANIC PARAMETERS IN GROUND WATER

PARAMETER	FEDERAL & STATE STANDARD[1]	HUMAN HEALTH EFFECT[2]
Phenol (total)		3.5 ppm
Total Dissolved Solids	500.0 ppm (S) [1,000.0 ppm] (S)	
Chromium	0.05 mg/L (P)	
Lead	0.05 mg/L (P)	
Mercury	0.002 mg/L (P)	

[1]Federal and State of Texas primary and secondary drinking water standards denoted by (P) and (S), respectively. Secondary criteria based on aesthetics for water consumption while primary criteria are based upon health considerations.Regulatory references: Federal Register, 24 October 1980 and 7 September 1979; Texas Department of Health drinking water standards, revised 1 November 1980.

[] denotes State of Texas criteria is different from Federal criteria.

[2]U.S. EPA estimate of safe levels of toxicants in drinking water for human health effects (Federal Register, 28 November 1980).

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TABLE 4-2. REGULATORY GUIDELINES OR CRITERIA FOR ORGANIC COMPOUNDS DETECTED IN GROUND WATER

PARAMETER	HUMAN HEALTH EFFECTS[1] (ppb unless noted)	
Phenol (total)	3.5 ppm	
EPA Method 601 (Purgeable Compounds)		
1,1,1-Trichloroethane	18.4 ppm	
Trichloroethylene[2]	0.0	(27.0)[3]
1,2--Dichloroethane	0.0	(9.4)
Tetrachloroethylene	0.0	(8.0)
Methylene Chloride	0.15 mg/L[4]	
Chloroform, Bromoform, Bromodichloromethane, Dibromochloromethane.	0.10 mg/L[5]	
EPA Method 602 (Purgeable Aromatics)		
Benzene	0.0	(6.6)[3]
Toluene	14.3 ppm	
Ethyl Benzene	1.4 ppm	
1,2-Dichlorobenzene	4000.0	

(1) U.S. EPA estimate of safe levels of toxicants in drinking water for human health effects (Federal Register, 28 November 1980).

(2) Also known as Trichloroethene.

(3) EPA has recommended human health effects criteria of zero (0) for carcinogens, but notes that this level may currently be nonfeasible. The Agency provides criteria for achieving various levels of protection on an interim basis. The levels which may result in a $10E^{-5}$ incremental increase of cancer risk over a lifetime are presented in parenthesis in ppb unless noted. These risks would permit one case of cancer per 100,000 people exposed. (Federal Register, 28 November 1980.)

(4) U.S. EPA SNARL Review, December 1980.

(5) Criteria for total trihalomethane.

of the compounds are proven or suspected animal carcinogens, therefore, zero consumption is recommended for the protection of human health. Many are also regulated as hazardous waste under RCRA (40 CFR Parts 262 and 263). For each site, detected compounds are compared to available standards and criteria. Table 4-3 lists EP Toxicity and Ignitability limits for the hazardous wastes, as defined by RCRA.

The use of human health criteria and standards for comparison of ground-water contamination at Sheppard AFB provides a stringent evaluation. Since the shallow ground water at the Base is not used as a water supply source, contaminants in-situ have neither human health nor environmental consequences. As these contaminants exit from a shallow ground-water system, they encounter potential receptors. Where contaminants are recharged in a regional system, they have direct human health implications. The potential for human contact and exposure exists when waters come to the land surface, either as seeps or as ground-water outflow to streams. Since a formal assessment of environmental and human health risks associated with the occurrence of contaminants is beyond the scope of this program, the alternative use of human health standards and criteria is considered reasonable and prudent.

4.2 Waste Pits

Work performed at the Waste Pits consisted of geophysical surveys, drilling, and sampling. The two geophysical surveys (resistivity and electromagnetics) were performed to aid in the location of Waste Pit boundaries and in the selection of monitor well locations. Three coreholes were drilled, one in each of the Waste Pit locations, to obtain soil samples for analyses. Two monitor wells were drilled and subsequently plugged due to the absence of ground water. Surface water samples were drawn from two points along Bear Creek and analyzed.

TABLE 4-3. RCRA STANDARDS FOR SOLID WASTE

PARAMETER	MAXIMUM CONCENTRATION IN EXTRACTANT (mg/L)
EP TOXICITY[1]	
Arsenic	5.0
Barium	100.0
Cadmium	1.0
Chromium	5.0
Lead	5.0
Mercury	0.2
Selenium	1.0
Silver	5.0
IGNITABILITY[1]	
A flash point less than 140°F.	

[1]Levels based on RCRA regulations, 40 CFR 26124 regarding waste material.

4.2.1 Results of Investigation

Topography

The former Waste Pits were located on a floodplain area of Bear Creek which is characterized by flat lying topography. The pits are bordered on the north and east sides by a steep bank that rises about 15 feet from the floodplain to the higher ground where Base facilities are located. A swampy area is located along Bear Creek. The Waste Pits and surrounding land elevations range from 980 feet at the floodplain to 995 feet at the top of the banks of Bear Creek. Figure 4-2 illustrates the locations of the coreholes, borings and surface water sampling points at the Waste Pits. As previously noted, the pits were removed in the mid-1970s. Therefore, there is presently no topographic expression of the previous pits.

Geology

Generally, the substrate consists of dry, hard, dark reddish brown clay. Figure 4-3 shows the location of a north-south cross-section, and Figure 4-4 depicts a generalized cross-section of the area. In one boring (B-1), a thin layer of silt was encountered at the surface. Sandy clay was found in Boring B-3 and Corehole C-2. The sandy clay may be a floodplain deposit or the result of landfill activity. Detailed geologic logs of drilling operations are located in Appendix D. The geologic characteristics of the Waste Pits found during drilling are consistent with the regional geology of the Wichita Falls area as well as Sheppard AFB.

Geophysical Surveys

Electromagnetics (EM) was the primary geophysical technique used at the Waste Pits. The EM-31 and EM-34 instrument were used to profile the site. A rectangular-shaped grid 140 feet by 300 feet was flagged at a 20-foot interval (Figure 4-5). At each flag, geophysical data was obtained from depths of

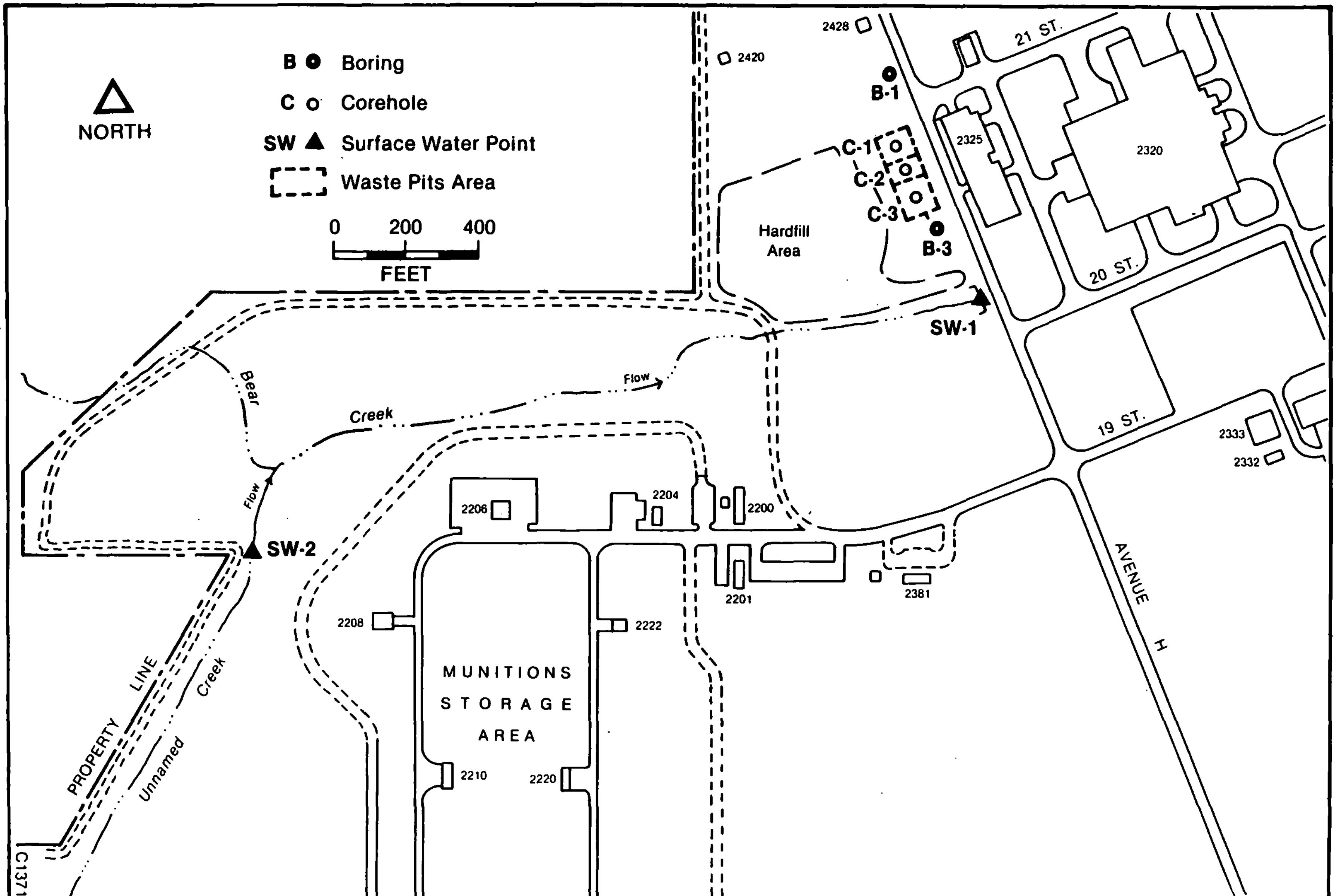

FIGURE 4-2. LOCATIONS OF COREHOLES, BORINGS, AND SURFACE WATER SAMPLING POINTS VICINITY OF WASTE PITS, SHEPPARD AFB, TX

June 1986

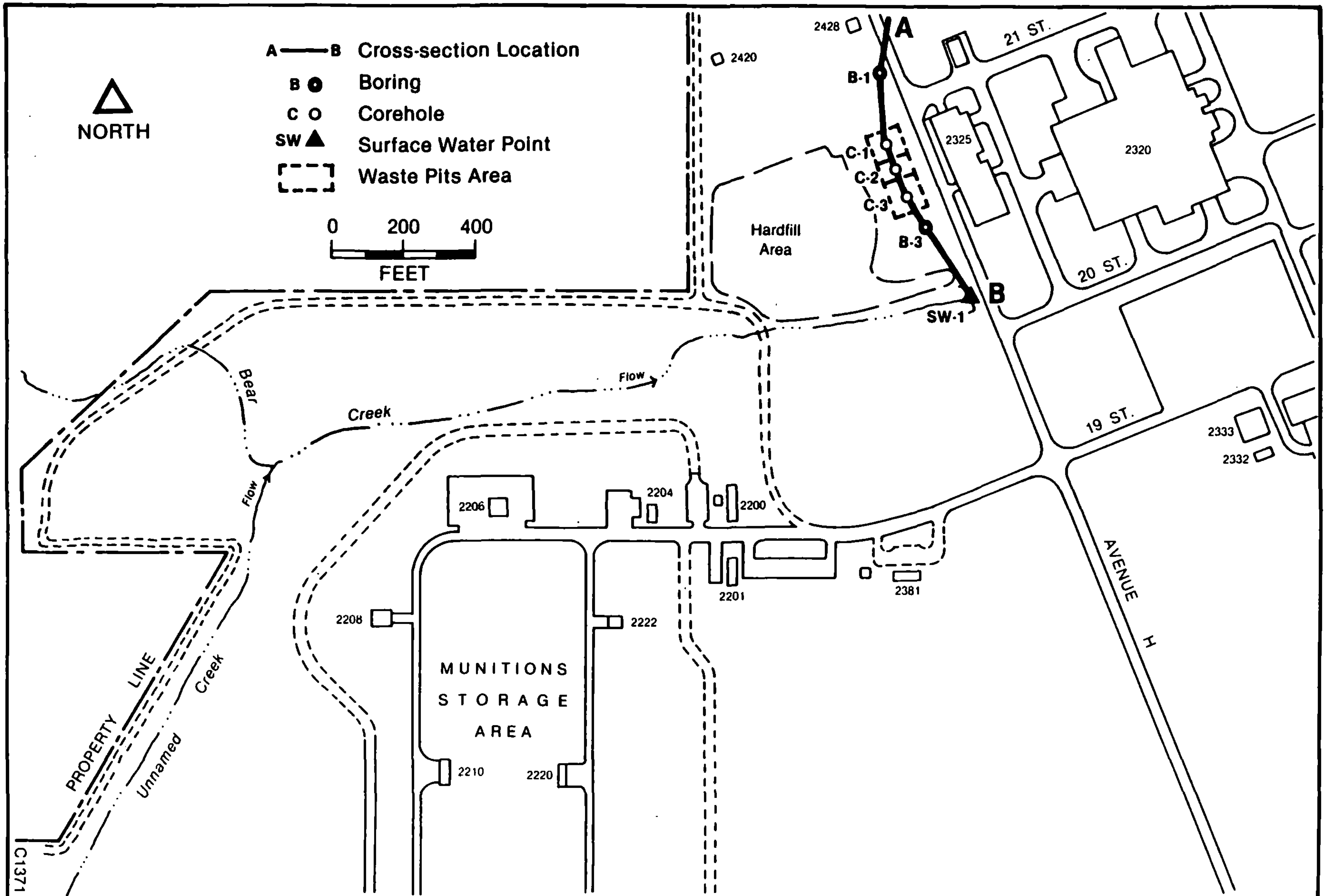

FIGURE 4-3. CROSS SECTION A-B, LOCATION AT WASTE PITS, SHEPPARD AFB, TX

June 1986

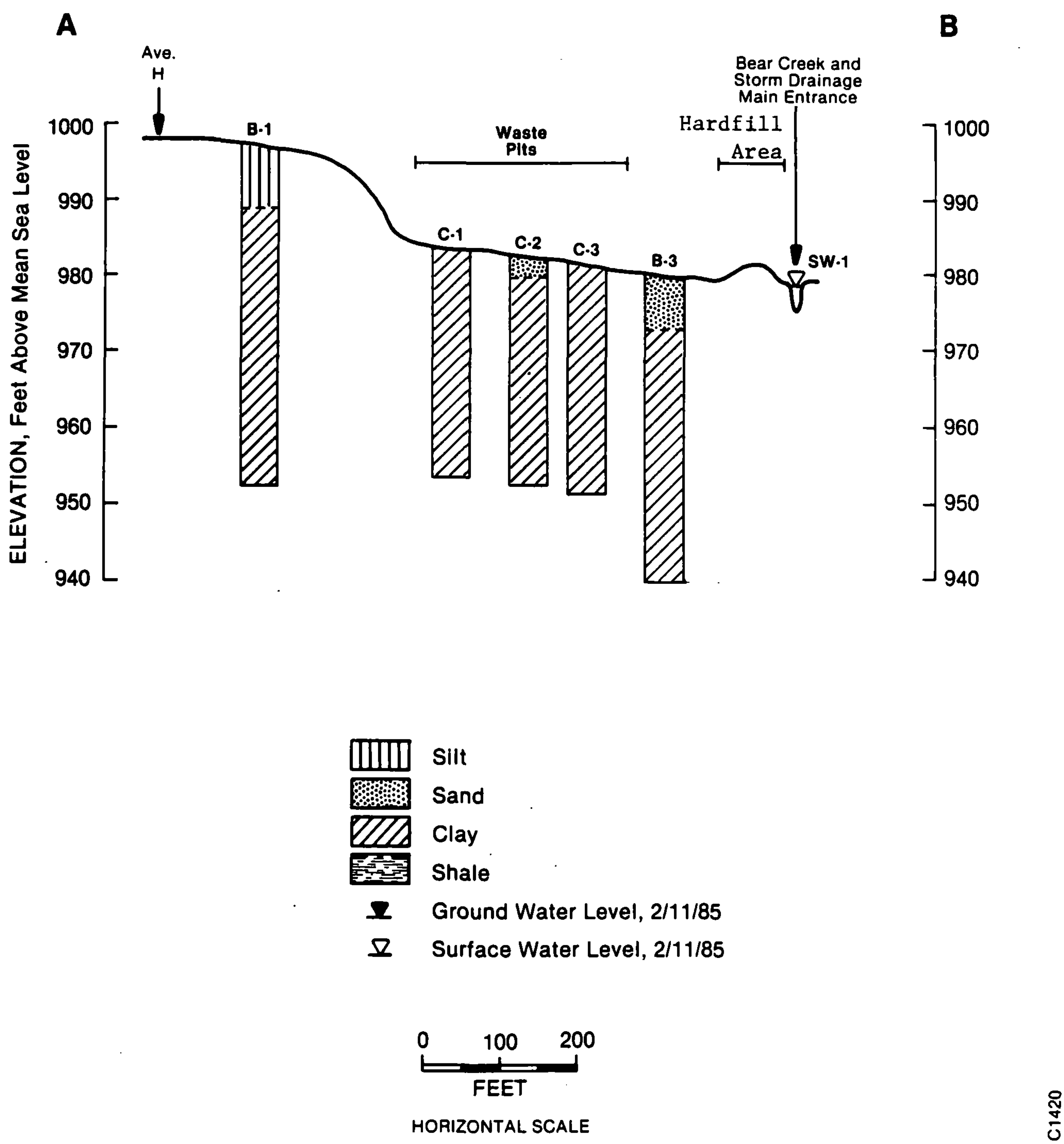

FIGURE 4-4. GENERAL GEOLOGIC CROSS SECTION A-B VICINITY OF WASTE PITS, SHEPPARD AFB, TX.

June 1986

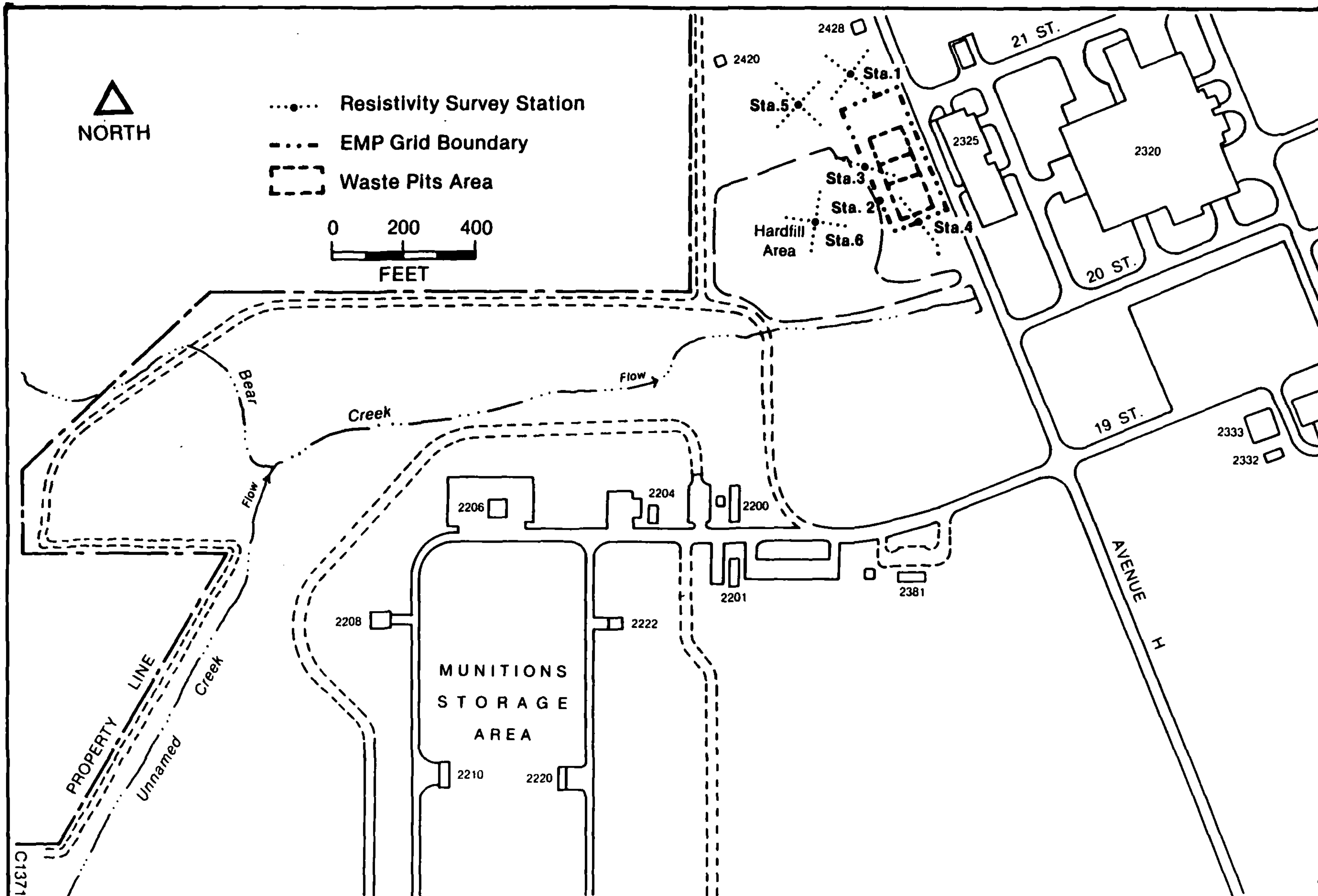

FIGURE 4-5. LOCATION OF EM AND RESISTIVITY SURVEYS, VICINITY OF WASTE PITS, SHEPPARD AFB, TX

June 1986

approximately 10, 20, and 45 feet to evaluate vertical as well as lateral changes in conductivity.

Electromagnetic measurements indicate overall high conductivity values associated with the subsurface materials. The conductivity values were in the order of 125-150 umhos. Figure 4-6 depicts an example of the 10-foot depth of investigation showing the high values. The readings are most likely reflective of the clays in the subsurface. Clays generally show high conductivity readings, particularly if wet, such as those taken from the adjacent marshy areas of Bear Creek. These values could be an indication of contamination, but no obvious trends could be seen. The Waste Pits could not be defined from the EM data. Detailed EM profiles are provided in Appendix L.

Resistivity soundings were taken at six locations which are depicted on Figure 4-5. The soundings showed consistent low resistivity values both in and out of the Waste Pit area. The general resistancy values were determined to be about 6 to 8 ohm-meters which indicates materials of high conductivity such as clays. The resistivity data correlated well with the EM data. More resistive material was not detected at depths.

Soil Sampling

Shallow soil sampling was conducted after the field geophysics were completed. One corehole was drilled at each of the three Waste Pit areas, which were determined from past aerial photography of the Base. Each corehole was drilled to a depth of about 30 feet. Coring samples were obtained for chemical analyses and subsurface examination. The soil sampling depths were selected to maximize subsurface information regarding any vertical and lateral movements of contaminants. A total of 21 soil samples were collected from the three coreholes. No obvious waste material was identified in any sample. The soil sampling scheme is summarized on Table 4-4. Tables 4-5, and 4-6 show those compounds detected in the soil samples collected and analyzed.

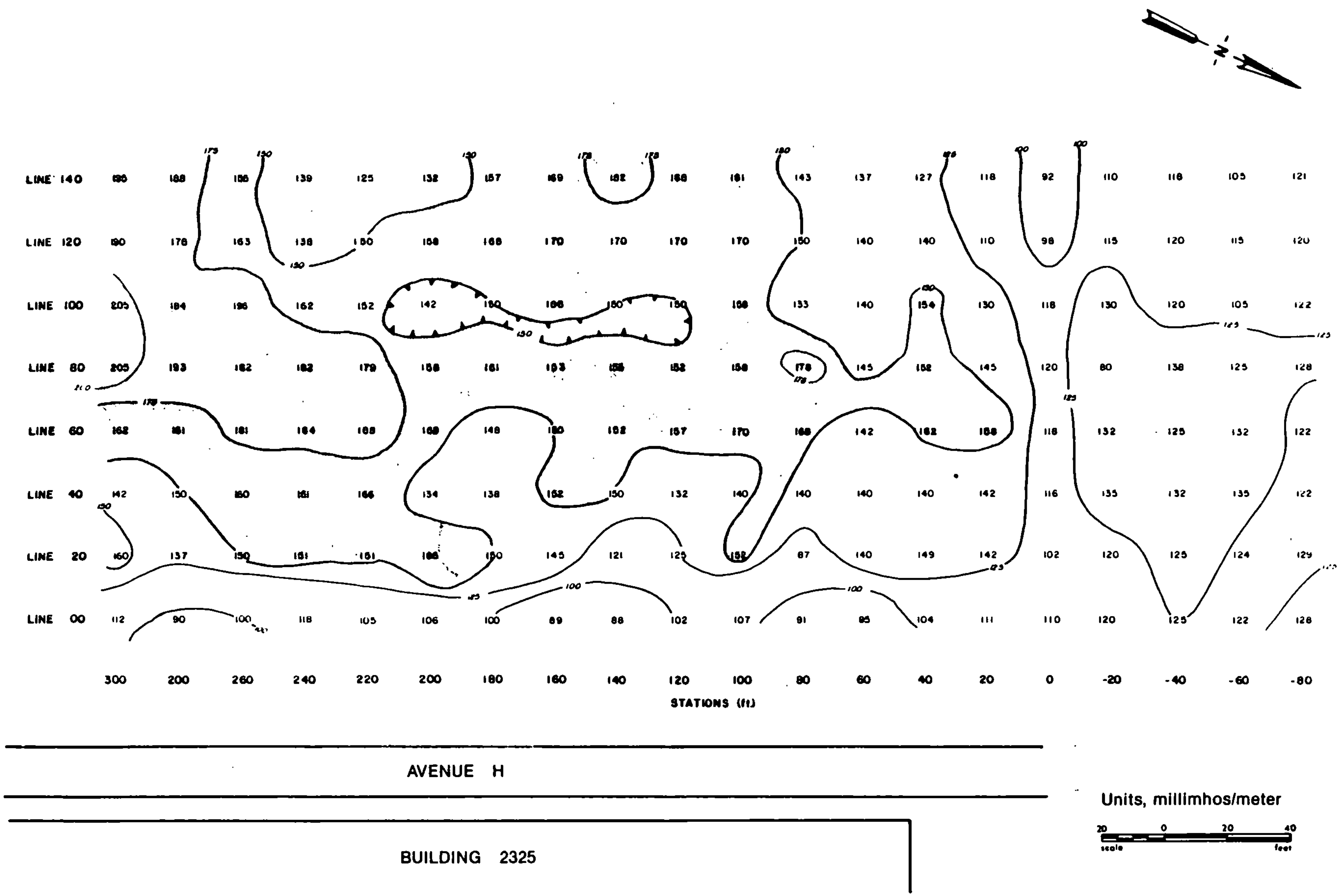

FIGURE 4-6. RESULTS OF ELECTROMAGNETIC SURVEY, 10 FOOT DEPTH OF INVESTIGATION, VICINITY OF WASTE PITS, SHEPPARD AFB, TX

June 1986

TABLE 4-4. WASTE PITS COREHOLE SAMPLING SCHEME

DEPTH	COREHOLE C-1	C-2	C-3
2.5		X	
5.0	X	X*	X
7.5		X	
10.0	X	X	X*
12.5			
15.0	X*		X
17.5			X
20.0	X		
22.5			
25.0	X	X	X
27.5			
30.0	X	X	X

Note: X = Sample collected.
* = Duplicate field sample collected for EP toxicity and ignitability analyses.

TABLE 4-5. RESULTS OF SOIL ANALYSES, WASTE PITS, SHEPPARD AFB

COREHOLE NUMBER	SAMPLE DEPTH (feet)	BASE SAMPLE NUMBER	PHENOL (ug/g)	TOC (%)	OIL & GREASE (ug/g)	pH (pH units)
C-1	5.0	840149	9.7	0.10	<500	8.05
	10.0	840150	5.0	0.24	<500	7.56
	15.0	840151	1.3	0.27	<500	8.51
	20.0	840152	<0.1	0.19	<500	8.79
	25.0	840153	<0.1	0.06	<500	7.82
	30.0	840154	<0.1	0.08	1,600	8.27
C-2	2.5	840163	4.5	0.10	<500	9.84
	5.0	840164	<0.2	0.12	<500	9.32
	5.0 QC	840165	3.5	0.07	<500	9.52
	7.5	840166	<0.2	0.16	<500	9.64
	10.0	840167	<0.2	0.25	600	9.50
	10.0 QC	840168	<0.2	0.25	800	9.45
	25.0	840169	<0.2	0.08	900	9.86
	30.0	840170	<0.2	0.06	900	9.92
C-3	5.0	840156	<0.2	0.07	500	9.79
	5.0 QC	840157	<0.2	0.06	500	9.26
	10.0	840158	<0.2	0.11	<500	9.33
	15.0	840159	<0.2	0.28	<500	9.61
	17.5	840160	<0.2	0.17	20,000	9.85
	25.0	840161	<0.2	0.17	14,000	10.04
	30.0	840162	6.4	0.09	<500	9.93

TABLE 4-6. ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES, WASTE PITS, SHEPPARD AFB, TEXAS

COREHOLE NUMBER	DEPTH (feet)	SAMPLE NUMBER	1,2-DICHLORO-BENZENE SW-8010,-8020 (ug/g)	1,3-DICHLORO-BENZENE SW-8010,-8020 (ug/g)	1,4-DICHLORO-BENZENE SW-8010,-8020 (ug/g)	CHLORO-BENZENE SW-8010 (ug/g)
C-1	5.0	840149				
	10.0	840150				0.175*
	15.0	840151	9.360, 9.260	1.890, 1.960	5.080, 6.550	0.277*
	20.0	840152	5.590, 4.080	1.200, 1.110	3.560, 3.060	0.257*
	25.0	840153	0.507, 0.731			
	30.0	840154	0.165*			
C-2			* * * No organic compounds detected. * * *			
C-3			* * * No organic compounds detected. * * *			

*NOTE: Compound identity not confirmed by second GC column. Therefore, this result may not be valid.

During coring activities, the dominant material encountered was dry clay. Organic vapors were noted in Corehole C-1 at 15 and 20 feet and in the protected open hole after it had been sitting for several days. Figure 4-4 shows the graphic logs of the 30-foot deep coreholes; detailed logs are provided in Appendix D.

Soil Chemistry

The 21 soil samples taken during the coring activities were described and examined for evidence of contamination. Selected core samples were sent to Radian Analytical Services for chemical analyses required by the Statement of Work (Appendix B). The samples that were analyzed were chosen to provide maximum vertical and lateral coverage of soil chemistry at the pits. The results of the inorganic chemical analyses are provided on Table 4-5, while those for the organic compounds are presented on Table 4-6. Other selected samples were obtained for EP toxicity and ignitability testing.

Phenols were detected in the shallow soils at Coreholes C-1 and C-2. Oil and grease was detected in all coreholes mainly at depths below ten feet, but centering about the 20-foot level. The only organic compounds detected were chlorinated solvents at Corehole C-1, which centered about the 15- to 20-foot level. Other levels were noted to have solvents by using the EPA method SW-8010, but were not detected by EPA method SW-8020. EPA Method SW-8020 detects some common compounds found in SW 8010 analyses. The SW 8010 and SW 8020 analyses were run using two different columns and two different detectors.

The detection limits for Methods SW-8010 and 8020 were 0.025 ug/g and 0.250 ug/g respectively. The single analytical values on Table 4-6 for chlorobenzene were detected by Method SW-8010 but not found with the detection limit by Method SW-8020; nor was second column confirmation done based upon applicable OEHL guidelines. Therefore, these analytical values are considered not reflective of actual soil conditions. In several cases a compound was detected by method SW-8020 but not by the more sensitive method SW-8010. Therefore, the single SW-8020 results are considered unreliable and were not used in Table 4-6.

Occurrence of Ground Water

In addition to the coreholes discussed above, two borings were drilled in order to detect ground water. The locations of the borings (B-1 and B-3) are depicted on Figure 4-2. Both boreholes were plugged when the subsurface geological conditions were found to be similar to those at the coreholes, namely mostly dry clays. The borings ranged in depth from 40 to 45 feet. A third prospective monitor well location had been planned for drilling in the area between the Waste Pits and the Base landfill. After consultation with the OEHL Technical Monitor, this monitor well location was not drilled because of the five (previously drilled) clay holes. The generalized log of the boreholes is depicted on Figure 4-4 along with the coreholes. No ground water was encountered, nor did any collect in the various holes when they were covered over and permitted to stay open for a number of days.

Surface Water

Surface water samples were also collected at two points shown on Figure 4-2. Location SW-1 is downstream from the Waste Pits. Location SW-2 serves two functions: first, it is downstream of Landfill No. 3 (discussed later); and second, it is upstream of the Waste Pit area. Results of the analyses are shown on Tables 4-7 and 4-8.

Other Samples

Three grab samples of drill cuttings were collected during the field activities, one from each corehole. These samples were then submitted for EP toxicity and ignitability testing. The results provided data for determining final drill cutting disposition. The results of the analyses are provided

TABLE 4-7. RESULTS OF WATER ANALYSES, VICINITY OF WASTE PITS, LANDFILL NO. 3, AND HARDFILL AREA

SAMPLE LOCATION	BASE SAMPLE NUMBER AND DATE OF COLLECTION (1)	PHENOL (mg/L)	TOC (mg/L)	OIL & GREASE (mg/L)	TDS (mg/L)	pH (pH units)	LEAD (mg/L)	CHROMIUM (mg/L)	MERCURY (mg/L)
SURFACE WATER									
Waste Pits									
SW-1	840190 (12/11/84)	0.07	12	6	510	7.62	NA (2)	NA	NA
	850012 (02/14/85) *	NA	10	- (3)	1,000	7.26	NA	NA	NA
	850089 (5/21/85)R	-	NA	NA	NA	NA	NA	NA	NA
SW-1 QC	850013 (02/14/85) *	0.009	10	-	1,000	7.28	NA	NA	NA
Landfill No. 3									
SW-2	840191 (12/11/84)	-	9	-	340	7.89	0.002	-	-
	850014 (02/14/85) *	0.026	6	-	1,200	7.57	-	-	0.0008
	850087 (5/21/85)R	-	NA	NA	NA	NA	NA	NA	NA
SW-5	840192 (12/12/84)	NA	5	1	245	8.36	0.005	-	0.0003
	850016 (02/14/85) *	NA	3	-	1,100	7.76	-	-	0.0006
GROUND WATER (LANDFILL NO. 3)									
MW-4	850010 (02/07/85)	NA	7	-	5,800	7.65	0.037	0.026	0.0066
	850015 (02/14/85) *	NA	-	-	4,000	7.39	0.013	0.013	0.0012
MW-4 QC	850011 (02/07/85)	NA	10	-	5,600	7.41	0.039	0.032	0.0038
MW-7	850008 (02/07/85)	NA	80	-	12,000	7.37	0.033	0.030	0.0036
	850017 (02/14/85) *	NA	26	-	1,500	7.38	-	0.022	0.0013

(1) Date of collection is expressed as (Month/Day/Year).
(2) NA denotes Not Applicable.
(3) - Denotes Not Detected.
* Asterisk denotes second round of sampling.
R Resample due to primary analyses exceeding hold time for phenols.

TABLE 4-8. ORGANIC COMPOUNDS DETECTED IN WATER, VICINITY OF WASTE PITS, LANDFILL NO. 3, AND HARDFILL AREA

RADIAN CORPORATION

SAMPLE LOCATION	BASE SAMPLE NUMBER AND DATE OF COLLECTION (1)	TRICHLORO-FLOURO-METHANE (ug/L)(2)	1,1,1-TRI-CHLORO-ETHANE (ug/L)	BROMODI-CHLORO-METHANE (ug/L)	TRICHLORO-ETHYLENE (ug/L) (3)	DIBROMO-CHLORO-METHANE (ug/L)	BROMOFORM (ug/L)	TETRACHLORO-ETHYLENE (ug/L)	TOLUENE (ug/L)	ETHYL BENZENE (ug/L)
SURFACE WATER										
Waste Pits										
SW-1	840190 (12/11/84)	0.3 (6)	0.6 (6)	1.3 (6)	-	3.4 (6)	5.5 (6)	-	-	-
	850012 (02/14/85) *	- (4)	-	-	-	-	-	-	-	-
SW-1 QC	850013 (02/14/85) *	-	-	-	-	-	-	-	-	-
Landfill No. 3										
SW-2	840191 (12/11/84)	0.6 (6)	-	-	-	-	-	-	-	-
	850014 (02/14/85) *	-	-	-	-	-	-	-	-	-
SW-5	840192 (12/12/84)	2.2 (6)	-	-	-	-	-	-	-	-
	850016 (02/14/85) *	-	-	-	-	-	-	-	NA	NA
	850086 (5/21/85)R	NA	NA	NA	NA	NA	NA	NA	NA	NA
GROUND WATER (LANDFILL NO. 3)										
MW-4	850010 (02/07/85)	-	-	-	1.6 (6)	-	-	1.2 (6)	-	-
	850015 (02/14/85) *	-	-	-	-	-	-	-	1.9 (6)	-
	850088 (5/21/85)R	NA(5)	NA	NA	NA	NA	NA	NA	-	-
MW-4 QC	850011 (02/07/85)	-	-	-	1.7 (6)	-	-	1.2 (6)	-	-
MW-7	850008 (02/07/85)	-	-	-	-	-	-	-	-	-
	850017 (02/14/85) *	-	-	-	-	-	-	-	-	2.7 (6)

(1) Date of collection is expressed as (Month/Day/Year).
(2) Trichlorofluoromethane deleted from toxic pollutants list 1981 (46 FR 2266).
(3) Also known as trichloroethene.
(4) - denotes Not Detected.
(5) NA denotes Not Applicable.
(6) Compound identity not confirmed by second GC column. Therefore, this result may not be valid.
* Asterisk denotes second round of sampling.
R Resample due to primary analyses exceeding hold time for EPA 602 analyses.

with the lab reports in Appendix H. The data indicate that no sample exceeded the EP toxicity limits. All sample flash points for ignitability were above the 140°F criteria.

4.2.2 Significance of Findings

The investigations at the Waste Pits were designed to confirm the geometry of the pits, define the soil chemistry, and detect any contaminant migration in the subsurface and nearby surface waters.

The geophysical survey results did not identify the boundaries of the Waste Pits, and no anomalies suggestive of contamination were detected in or out of the pit area. The high clay contents of the subsurface clearly influenced the geophysical readings.

The soil chemistry results showed the presence of organic solvents under the waste site mainly at Corehole C-1. The relic Waste Pits were not observed during coring activities, and discussions with Base personnel (Smith, 1984) indicated that the old pits were probably scraped away when their use was no longer required. This appears consistent with the field observations and the geophysical results. The fact that more chemicals were detected in Corehole C-1 is reasonable since this was the first pit to be used. The other two pits at Coreholes C-2 and C-3 were built afterwards to accommodate waste liquids that could not be handled by the first one.

The five borings and coreholes were drilled over a distance of about 450 feet in which the subsurface was predominantly clay. No ground water was observed. These observations are significant in that there is a low potential for contaminants to migrate from the site due to the low permeabilities and no apparent ground water that could promote leachate generation. Additionally, the adjacent marsh area and Bear Creek indicate little or no hydraulic communication with the soils under the Waste Pits.

Organic compounds were detected in surface water, only during the first sampling round, at the upstream sampling point SW-2 and the downstream sampling point at SW-1. The significance of the variability between the sampling episodes is related to the fluctuations of surface water flows and drainage sources. Additionally, since no ground water was found at the Waste Pits, the compounds detected are likely to be from a different source along Bear Creek and/or its tributaries. Table 4-9 summarizes the compounds detected in surface and ground water that exceed a water-quality regulation or guideline. Also shown are the analytical results from the Landfill No. 3 upstream. Total dissolved solids (TDS) exceeded the criteria for the two surface water and ground water samples and is most likely related to natural conditions rather than impacts from Landfill No. 3. TDS values in the Landfill 3 area range from 245 to 1200 ppm in surface waters and range from 1500 to 12,000 ppm in the ground water. Mercury exceeded the criteria for the two ground-water samples collected during the first round of sampling but not the second round of sampling. The reported mercury values (i.e., 0.0036 to 0.0066 mg/L) are somewhat above the criteria of 0.002 mg/L but no significant concern is justified at this time. This is because the outlier mercury values occurred only in one round of sampling which indicates natural and/or analytical variabilities. Other sampling would be required to confirm the mercury values that exceeded a criteria and substantiate any environmental concern. The ground water has been noted as being mineralized and often not suitable for drinking (Baker, 1972) in these areas.

Urban runoff is probably the major source contributing to the compounds detected in the water. Bear Creek and its tributaries drain large areas of the Base and corresponding personnel housing.

The significant findings are summarized below:

- some organic compounds were detected in the subsurface soil;
- ground water was not detected in the predominantly clay soils;

TABLE 4-9. WASTE PITS, LANDFILL NO. 3 AND HARDFILL AREA, SUMMARY OF GROUND WATER ANALYTE RESULTS EXCEEDING FEDERAL AND/OR STATE REGULATIONS OR GUIDELINES

SAMPLING SITE		ANALYTE AND RESULTS (1)	
		TOTAL DISSOLVED SOLIDS (S) (mg/L)	MERCURY (P) (mg/L)
	GUIDELINE (2)	500 (3) [1,000]	0.002
SURFACE WATER			
Waste Pits (Downstream)			
SW-1		- (5)	-
		1,000 *	-
Landfill No. 3 (Upstream)			
SW-2		-	-
		1,200 *	-
SW-5		-	-
		1,100 *	-
GROUND WATER (Landfill No. 3)			
MW-4		5,800	0.0066
		4,000 *	-
MW-4 QC		5,600	0.0038
MW-7		12,000	0.0036
		1,500 *	-

(1) Federal and State of Texas primary and secondary drinking water standards denoted by (P) and (S), respectively. Secondary criteria based upon aesthetics for water consumption while primary criteria are based upon health considerations. Regulatory references: Federal Register, 24 October 1980 and 7 September 1979; Texas Department of Health drinking water standards, revised 1 November 1980.
(2) [] denotes State of Texas criteria which is different from Federal criteria.
(3) Guideline concentration in mg/L, analytical results in (mg/L).
(5) - denotes that guidelines were not exceeded.
* Asterisk denotes results from the second round of sampling.

- o no apparent hydraulic communication exists between the Waste Pits and nearby Bear Creek; and

- o levels of total dissolved solids exceeding Federal guidelines (see Table 4-8) detected in Bear Creek at surface water point SW-1 may be related to natural soil conditions along Bear Creek; however, some might be attributable to urban runoff and recent Base hardfilling activities adjacent to the waste pits.

4.3 Landfill No. 3 and Hardfill Areas

Work performed at the site consisted of conducting geophysical surveys consisting of EM, resistivity and magnetometry. After the geophysical surveys, two ground-water monitor wells were installed, and ground water was sampled and analyzed. Two surface water points were located to obtain surface water samples for chemical analyses. The results and significance of the hydrogeologic and chemical data are discussed in the following paragraphs.

4.3.1 Results of Investigation

Topography

Landfill No. 3 and the Hardfill areas are located on gently northward sloping topography. Each of these sites form two distinctive areas. The Landfill was built into trenches below ground level, while the Hardfill area was built above the ground. The areas about most of the Landfill are gently rolling. The Hardfill area rises approximately 15 feet above this rolling surface. The general areas of these sites are shown on Figure 4-7. The elevations range from about 995 feet at the northern end to 1,025 feet at the southern end of the Landfill. The Landfill area is quite distinct in that the topographic features are expressed as hummocky, grass-covered terrain. Much of the rolling aspect of the terrain is due to the slight depressions at the relict trenches where some settling has occurred.

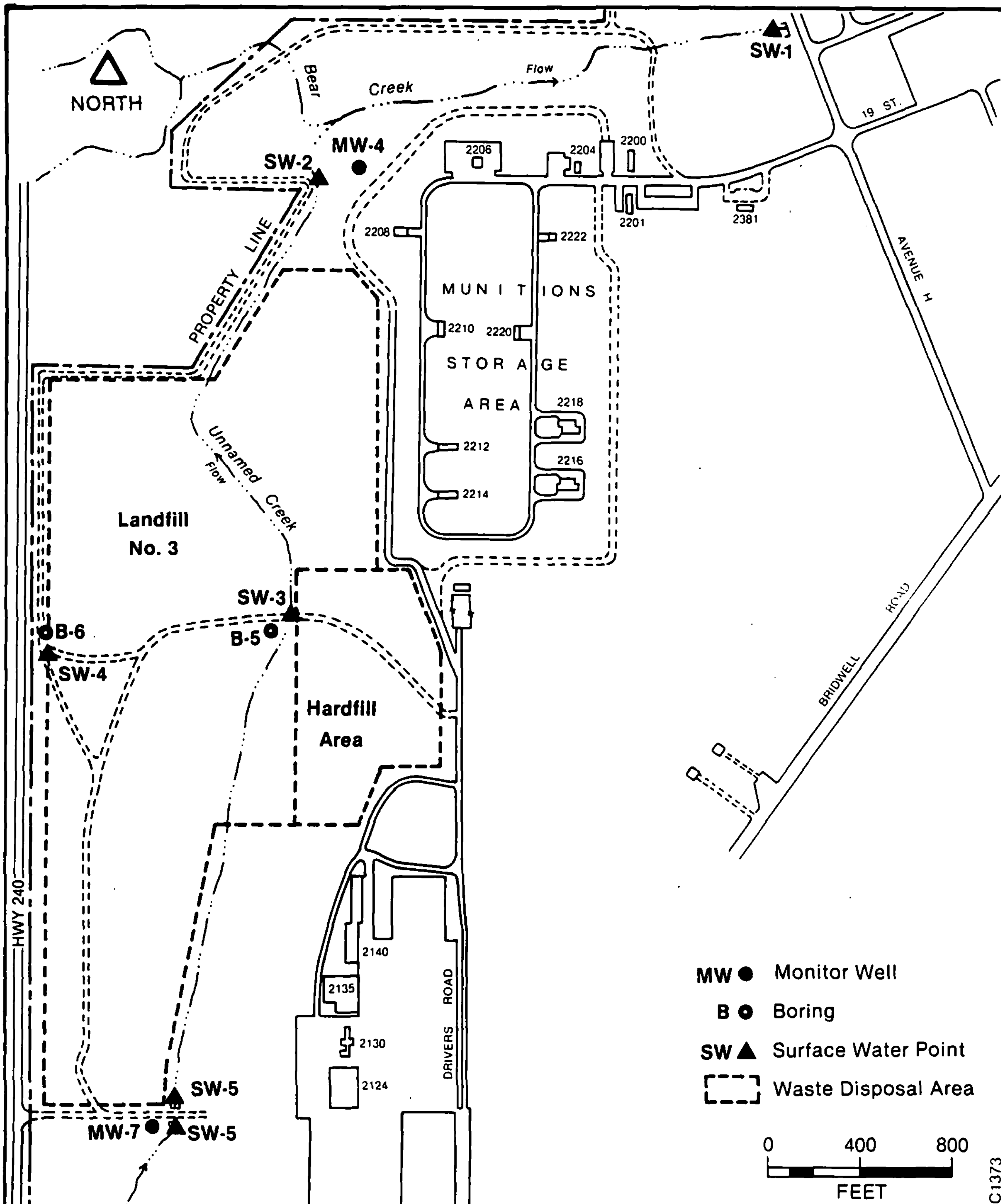

FIGURE 4-7. LOCATION OF LANDFILL NO. 3 AND HARDFILL AREAS, SHEPPARD AFB, TX.

June 1986

The area drains through several small tributaries to unnamed creeks which then merge with Bear Creek to the north. These creeks form steeply sided gullies throughout much of the area. Several low areas along the creeks are marshy with thick vegetation.

Geologic Features

The geologic features of the study site observed during the drilling activities were consistent with the regional geologic setting of the Wichita Falls area and the known geologic conditions at Sheppard AFB. Additional information was obtained with the geophysical surveys.

Generally, the substrate consists of thin layers of top soil underlain by reddish brown clays and clayey silts. The high clay content appeared to exist throughout most of the site while siltier areas occurred at the north end of the site.

Geophysical Surveys

The primary means for investigating the Landfill and Hardfill areas with geophysics was with electromagnetics (EM). EM-31 and EM-34 instruments were used to profile the study site. A rectangular grid of 1,500 feet by 3,600 feet was flagged about the area (Figure 4-8). Point station measurements were taken at every 50 feet. At each station, EM data was obtained from depths of approximately 10, 20, and 45 feet. Using these three data sets, vertical as well as lateral changes in conductivity were evaluated about the Landfill and Hardfill areas. The EM was used to provide information on the waste site boundaries, locations, and depths of disposed trenches.

Electromagnetic measurements indicated a wide range of conductivity values associated with the subsurface materials. Additionally, the EM readings were not conducted in two general areas. Those were very marshy areas with heavy brush along the creek and the Base firing range. The large amount

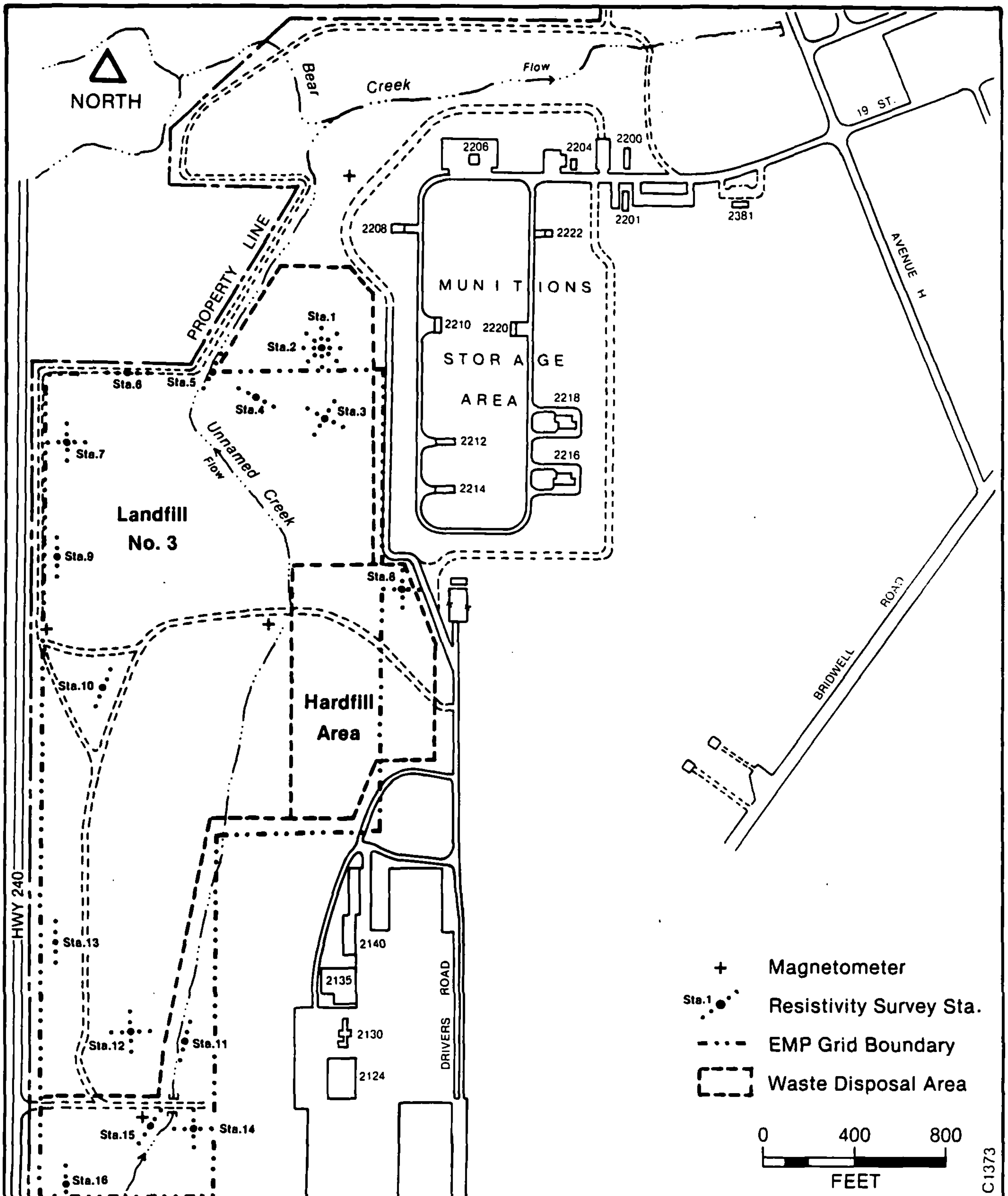

FIGURE 4-8. EM GRID AREA & RESISTIVITY POINTS FOR LANDFILL NO. 3, SHEPPARD AFB, TX.

June 1986

of trench and filling, multiple fill types, and refuse found in the area hinder accurate interpretation of the data. The trench boundaries were not evident from the data, and there were no apparent conductivity changes in areas of known trenches. Somewhat higher conductivity values are associated within the southern half of the grid. An example is shown on Figure 4-9. The highlighted or darker areas represent data of generally higher conductivities than other areas of the Landfill. The general resistivity values were determined to be about 4 to 7 ohm-meters, which indicates highly conductive material such as clay strata. These values are similar to those determined at the Waste Pits which are underlain by clay. Furthermore, the resistivity data correlate well with the EM data. More resistive material was not detected at depths which could have reflected consolidated formations.

Resistivity values vary according to the degree of soil compaction, sandlayers and water content. For example, the water content varied considerably from one resistivity station to the next. As an example, station No. 4, shown on Figure 4-8, provided the best estimate for waste disposal trench depth. The resistivity survey results for Station No. 4 are shown on Figure 4-10. The trench depth at Station No. 4 is estimated to be about 10 feet deep or about the 3 to 4 meter mark on the horizontal scale on Figure 4-10. This adequately agrees with the Phase I reported depths of about 14 feet. Although the resistivity data are highly affected by the lateral variabilities in the soils and require careful judgment in their interpretation, the data did provide general trends for selecting monitor well location. The remaining geophysical figures are in Appendix L.

After the resistivity surveys, four locations were selected for monitor well installation. Magnetometry was used to screen the sites to detect metal objects that could interfere with drilling. A fifty-foot square grid was centered about the prospective monitor well location. Magnetometry readings were taken every five feet. The results are contoured similar to EM readings. No magnetic anomalies were detected indicating the absence of large

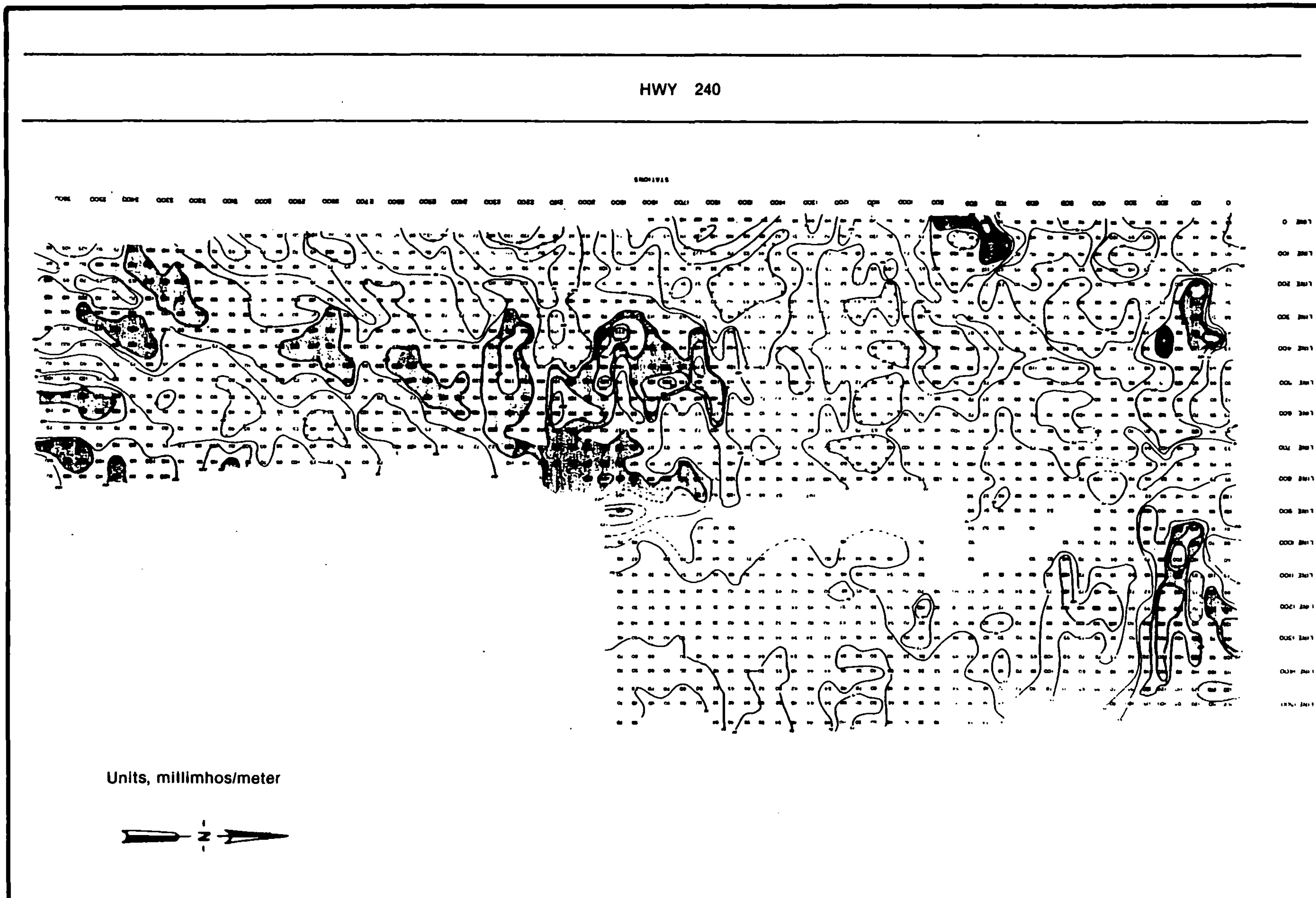

FIGURE 4-9. RESULTS OF ELECTROMAGNETIC SURVEY VICINITY OF LANDFILL NO. 3 AND HARDFILL AREAS, SHEPPARD AFB, TX.

June 1986

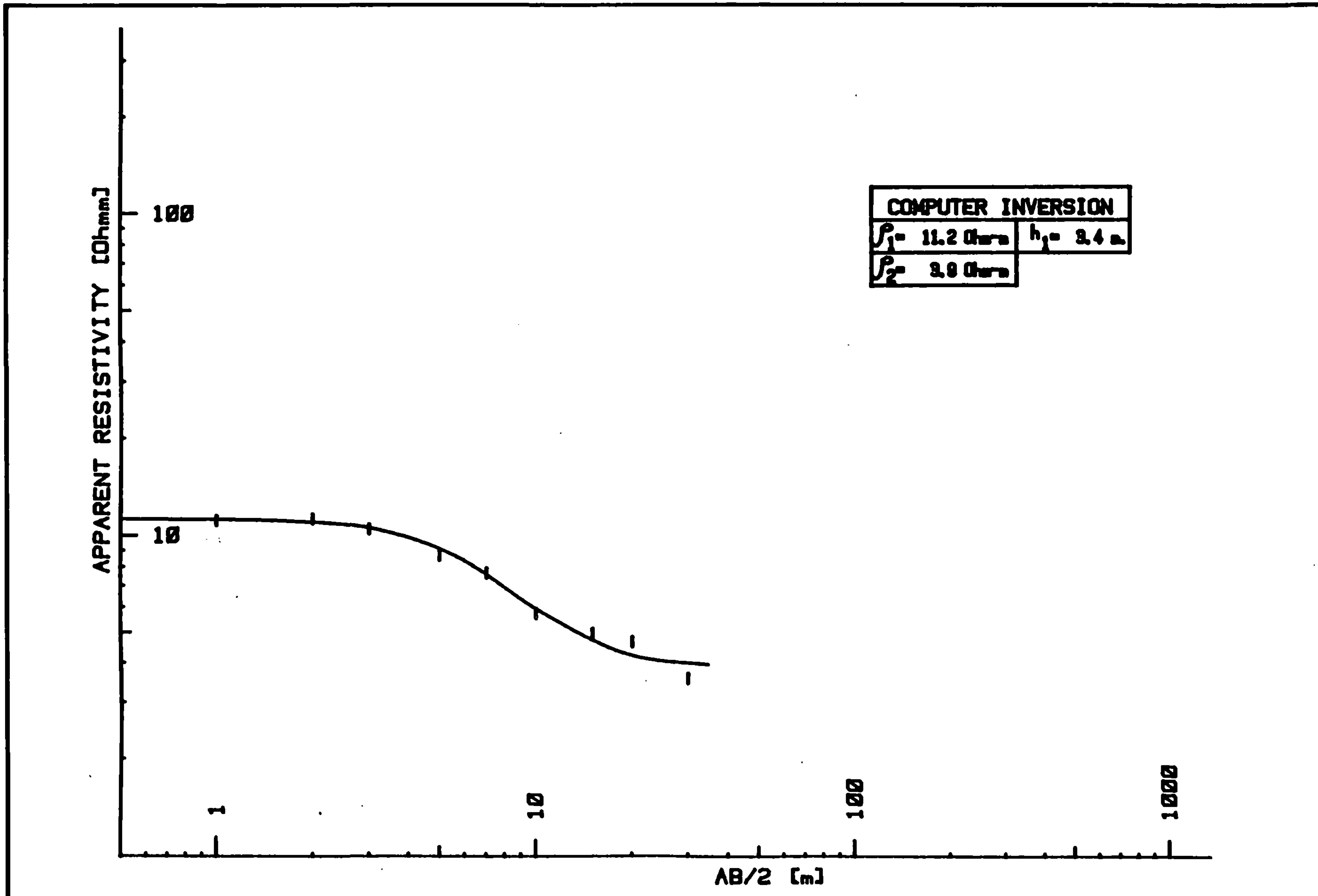

FIGURE 4-10. RESISTIVITY SURVEY STATION NO. 4 RESULTS VICINITY LANDFILL NO. 3, SHEPPARD AFB, TX.

June 1986

metal objects that would have interfered with drilling. The magnetometry results are provided in Appendix L.

Occurrence of Ground Water

Four locations were drilled in order to detect ground water, and monitor wells were subsequently installed where ground water was found. The locations drilled are shown on Figure 4-7 and designated as Borings B-5, B-6, and Monitor Wells MW-4 and MW-7. Cross-section locations are shown on Figure 4-11. Boring B-5 remained dry after standing open for one day; Boring B-6 remained dry after standing open for four days. The borings ranged in depth from 40 to 51 feet, at which depth the dominant material encountered was clay (Figure 4-12). Boring B-5 was drilled deeper to explore for any deeper aquifer. A very hard dry clay was encountered at Boring B-5 at about 50 feet, which greatly reduced the drilling rate (i.e., 1 foot drilled in 50 minutes). The cross-sections showing geologic conditions at monitor wells, along with the water-level data, are on Figure 4-13. Figure 4-14 is a map of ground-water elevations, also showing the depth elevation of the dry borings. The detailed information on the logs and monitor well completion data is provided in Appendix D.

Monitor Well MW-7 was drilled after the borings were completed. A small seep of ground water was encountered at about 20 feet within principally clayey soils. Although MW-7 produced a small amount of water, its ability to provide sufficient water for sampling was uncertain. It was decided, after consultation with the IRP Technical Monitor, to complete the well using PVC materials. Due to bad winter weather, Monitor Well MW-4 was drilled later than MW-7 and the other borings. At MW-4, the subsurface material was more permeable and contained shallow ground water.

The results of the drilling activities and field observations (i.e., outcrops at stream banks) indicated that clays exist throughout much of the

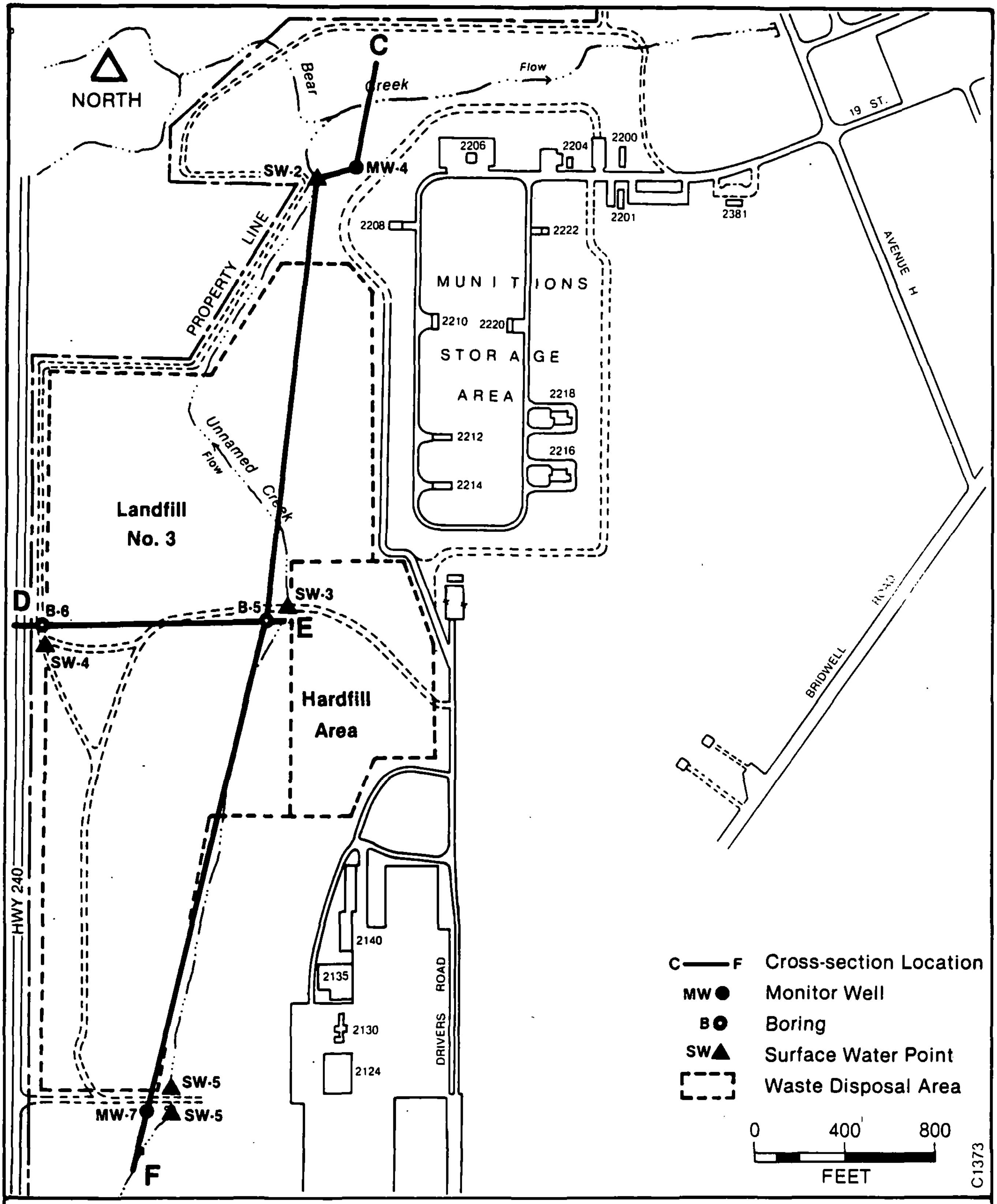

FIGURE 4-11. GENERAL CROSS SECTION LOCATIONS AT LANDFILL NO. 3 AREA, SHEPPARD AFB, TX.

June 1986

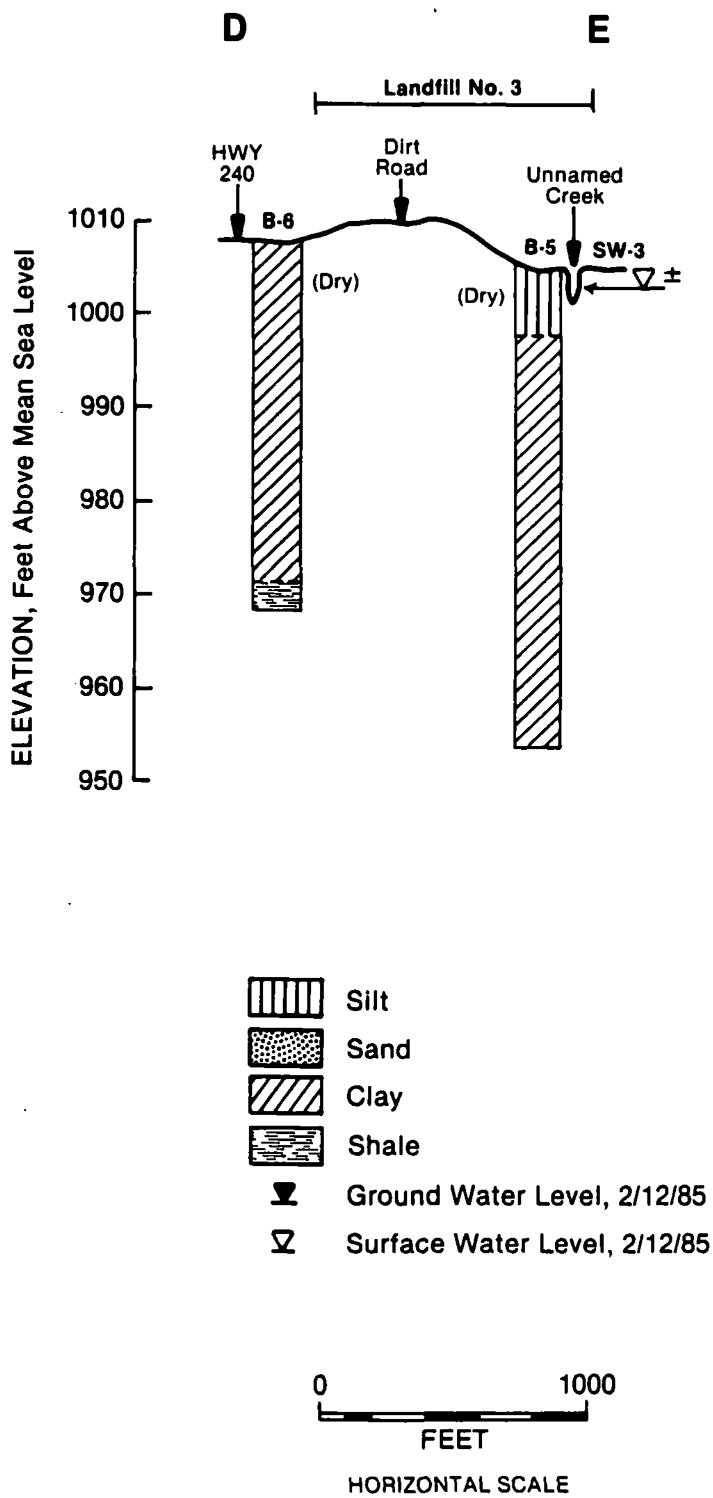

FIGURE 4-12. GENERAL GEOLOGIC CROSS SECTION D-E VICINITY OF LANDFILL NO. 3, SHEPPARD AFB, TX.

June 1986

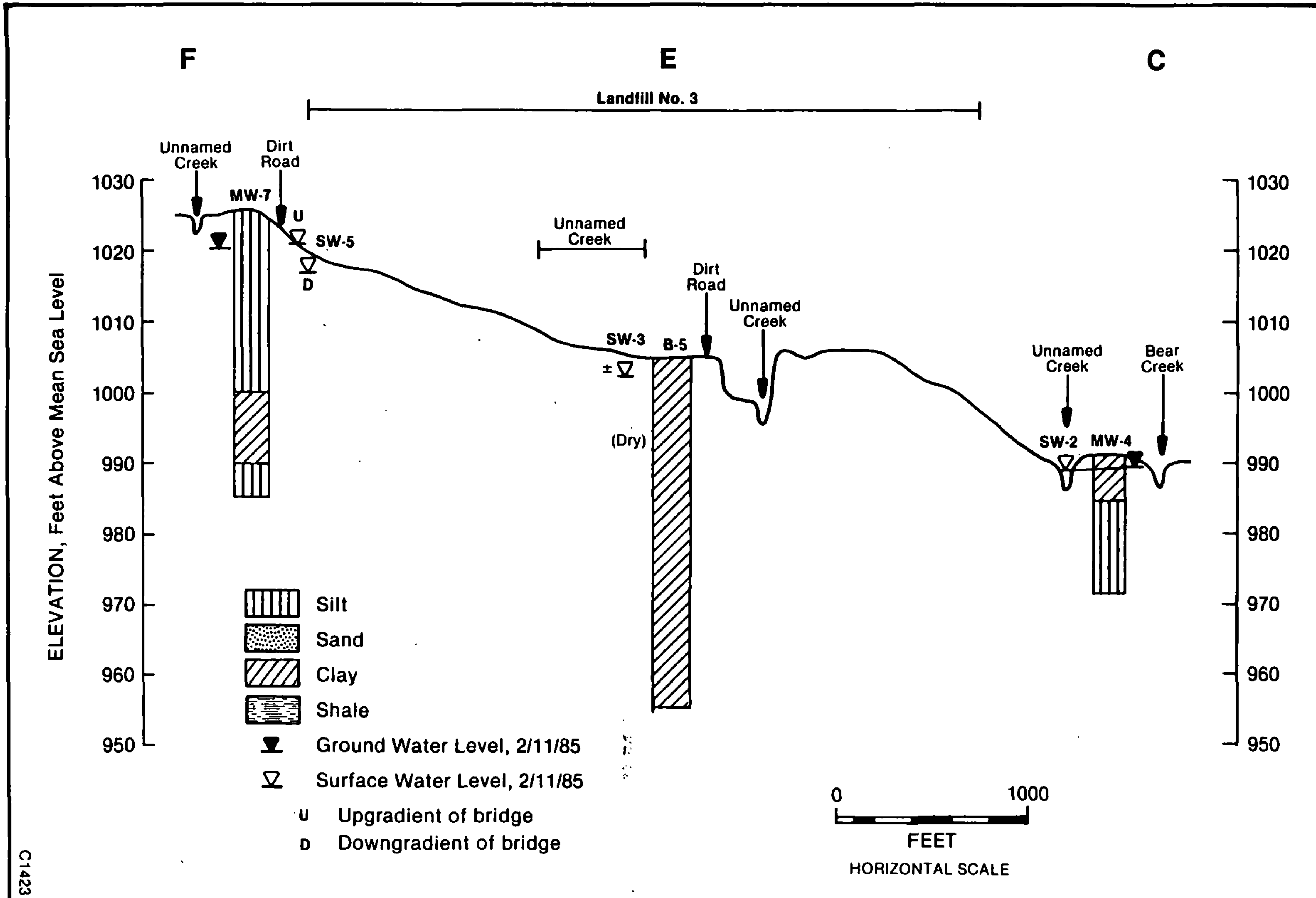

FIGURE 4-13. GENERAL GEOLOGIC CROSS SECTION F-C VICINITY OF WASTE PITS, SHEPPARD AFB, TX.

June 1986

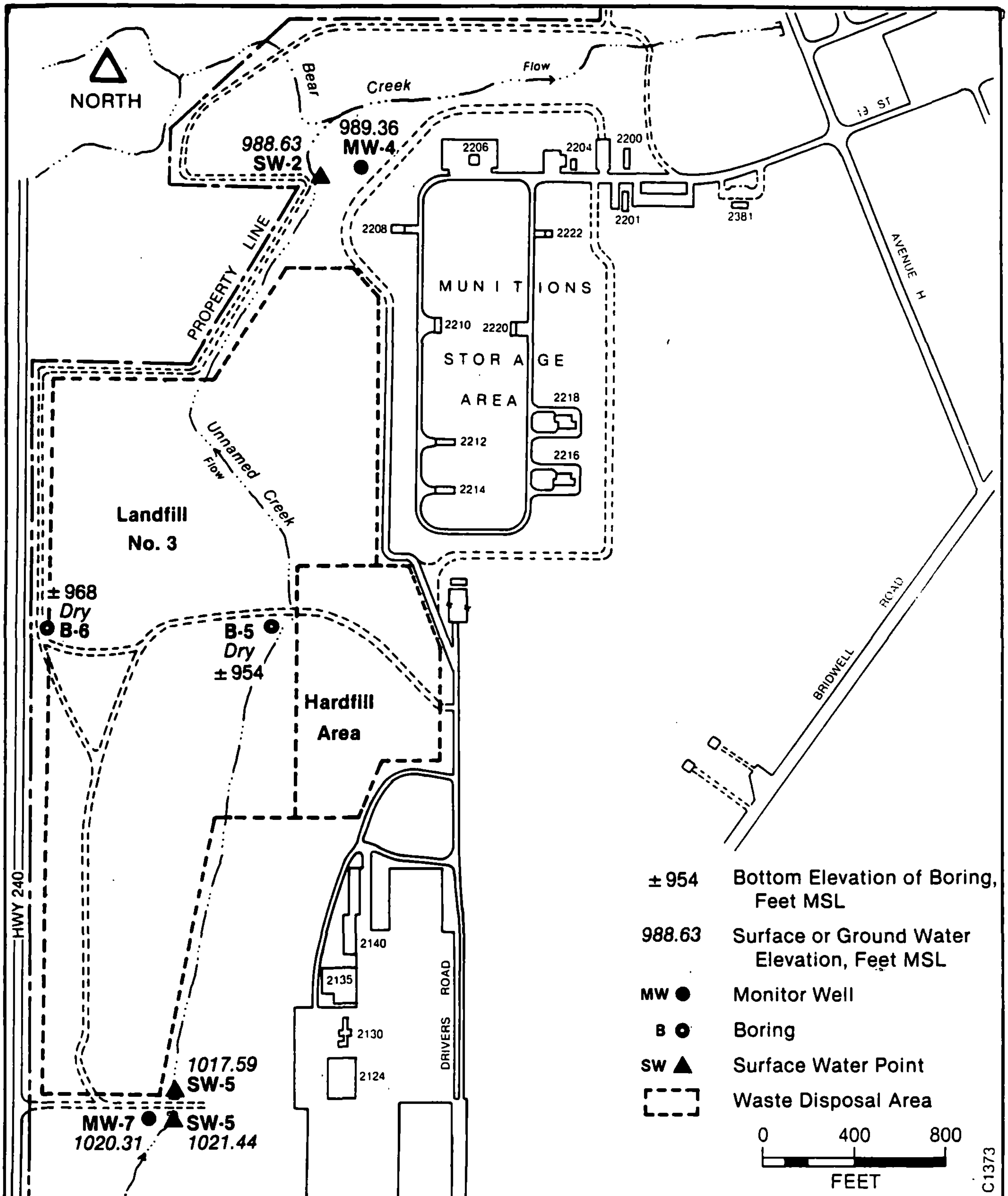

FIGURE 4-14. WATER LEVEL ELEVATIONS, VICINITY OF LANDFILL NO. 3 AND HARDFILL AREAS, SHEPPARD AFB, TX.

June 1986

Landfill and Hardfill areas. The clays were similar to those found at the Waste Pits, and no continuous aquifers were encountered.

Ground-Water Quality

The monitor wells were sampled after they were completed. Sampling activities were difficult due to extremely cold weather and low productivity of the monitor wells. The analytical results of the inorganic parameters are shown on Table 4-7 while those for organic compounds detected are summarized on Table 4-8. The complete analytical results are provided in Appendix H.

Surface Water

Surface water samples were also collected at selected locations shown on Figures 4-7 and 4-11. Surface water point SW-5 is located upstream from the site. Water level data were collected on both sides of the bridge at SW-5 where a drop in water level elevation of some four feet occurs. Water samples were collected on the south side only. Surface water point SW-2 serves two functions, to represent downgradient conditions for the study site and as the upstream location for water entering the Waste Pit area (discussed earlier). The analytical parameters based upon the IRP Phase I report provides indicators of potential contamination. Results of the analyses are shown on Tables 4-7 and 4-8. The complete analytical data are provided in Appendix H.

4.3.2 Significance of Findings

The investigations at the Landfill No. 3 and Hardfill areas were designed to confirm the Landfill boundaries and to detect contaminant migration in the subsurface and nearby surface waters.

The geophysical survey results show that the entire area is underlain by low resistivity strata, consistent with the drilling results.

However, the surveys could not define the actual boundaries of the Landfill area or the trenches. The high clay content and resultant low resistivity of the subsurface clearly influenced the geophysical survey which masked disposal site features.

Four borings, two of which encountered ground water, were drilled in or along the border of the Landfill No. 3 and Hardfill areas. Depths of the borings were 20 and 40 feet for the borings completed as monitor wells, and 40 and 51 feet for the two dry borings (Figure 4-11). The substrate, especially noted at the two dry borings (B-5 and B-6), is predominantly clay. Minor amounts of fine-grained materials were noted at the southern and northern borders. It's not certain if aquifers exist in other areas of the site due to the limited number of borings drilled and large area of the site.

Surface water and limited ground water in the Landfill area provide a small potential for contaminant movement. The surface drainage is from south to north along an unnamed creek which traverses the Landfill. The direction of ground-water flow cannot be determined with only two available data points (wells). Three points (i.e., monitor wells) would be needed. The two that are present are not known to be hydraulically connected. It is also unclear whether the surface water and ground water at Monitor Well MW-7 are hydraulically connected. However, hydraulic communication does exist between Unnamed Creek and Monitor Well MW-4, which was evidenced by corresponding water-level measurements between between MW-4 and Unnamed Creek.

Although trichlorofluoromethane was found in the surface water samples of the unnamed creek, the compound was only detected in water taken during the first of two sampling rounds (see Table 4-8). The largest concentration was from the samples from SW-5 on the unnamed creek and a smaller concentration noted at SW-1 on Bear Creek (see Figure 4-7). A probable reason for the compound not being detected during the second sampling round is due to exposure of the first round samples to a Freon source possibly introduced during shipment and/or storage. It is unusual to find this compound in a surface water due to its volatility. This compound, a very volatile air conditioning fluid, often occurs as a spuriously detected compound. The high vapor pressure of the compound creates the potential for a sample to acquire trichlorofluoromethane during transit or storage. Based upon present data, the compound was found in 6 of 7 samples all shipped in the same ice chest; its presence is not considered representative of natural or waste site conditions.

Table 4-9 summarizes the compounds detected in surface and ground water that exceed a regulation or guideline. Total dissolved solids exceeded the criteria for water collected at upgradient and downgradient areas for the surface water points (SW-2 and SW-5) and the two monitor wells (MW-4 and MW-7). This phenomenon is most likely related to natural conditions in the clayey substrate and urban runoff rather than impacts from Landfill No. 3 and Hardfill areas. Similar high TDS readings were noted at the Waste Pits downstream.

Although mercury was noted in both monitor wells from the first round of sampling, the concentration in MW-4 was about twice that found in MW-7. Mercury in ground water at the monitor wells may be due to natural conditions, but impacts from landfill activities cannot be discounted. The corresponding mercury content in soils was below detection limits when analyzed. Although no other data are available, the natural mercury content in clays is often higher than for other types of unconsolidated formations (Wedepohl, et al, 1970).

The significant findings are summarized below:

- Geophysical surveys revealed low-resistivity materials (i.e., clays) that obscured the Landfill No. 3 boundary and the trenches;

- No major contamination was detected with the limited number of borings drilled across a large site.

- Ground water occurs in discontinuous and isolated sections within clay;

- Ground-water flow direction could not be ascertained due to the uncertain aquifers and hydraulic communication in the area; and

- One metal (Hg) compound concentration exceeded Federal and/or State regulations and guidelines.

Presence of mercury may well reflect natural clayey conditions as well as the high total dissolved solids.

4.4 Fire Protection Training Area (FPTA) No. 3

The work performed at FPTA No. 3 consisted of conducting an electromagnetic (EM) survey followed by the installation of three ground water monitoring wells. The monitor wells were subsequently sampled for chemical analyses. A surface water control point was established at the nearby evaporation pond to obtain surface water samples for chemical analyses. The results and significance of the hydrogeologic and chemical data are discussed in the following paragraphs.

4.4.1 Results of Investigation

Topography

FPTA No. 3 is located on gently sloping land with a relief across the site of about 10 feet. The ground level elevation in the immediate vicinity of FPTA No. 3 trends from northwest to southeast with elevations ranging from about 995 feet msl to about 985 msl, respectively. The principal features are man-made as part of the fire training activities of the Base. Figure 4-15 illustrates the training area, as well as showing the locations of the monitor wells and the pond surface water sampling point.

Geologic Features

The geologic features of the study site observed during the drilling activities were consistent with the regional geologic setting of the Wichita Falls area and the known geologic conditions at Sheppard AFB. Additional information was obtained during the geophysical surveys.

Generally the substrate consists of thin layers of top soil underlain by reddish brown sand, silts and clays. The unconsolidated formation is permeable and contains ground water.

Geophysical Surveys

The primary means for investigating the fire protection training area with geophysics was with electromagnetics (EM). EM-31 and EM-34 instruments were used to profile the study site. The grid consisted of two sections. The northern section of the grid centered on the active fire training pit and the area connecting the pit to the evaporation pond (Figure 4-16). The southern section encompassed the evaporation pond. For the northern section, a rectangular grid of 100 feet by 200 feet was flagged about FPTA No. 3, and a grid of 300 feet by 200 feet was used about the evaporation pond. Stations were located every 40 feet on the grid. EM-31 readings were taken every 20 feet on the northern section. Readings in the southern section were taken every 20 feet on 40-foot space lines. At each station, geophysical data was obtained from depths of approximately 10- and 20-feet with the EM-31, and from 45 feet with the EM-34. Using these three data sets, vertical as well as lateral changes in conductivity were evaluated.

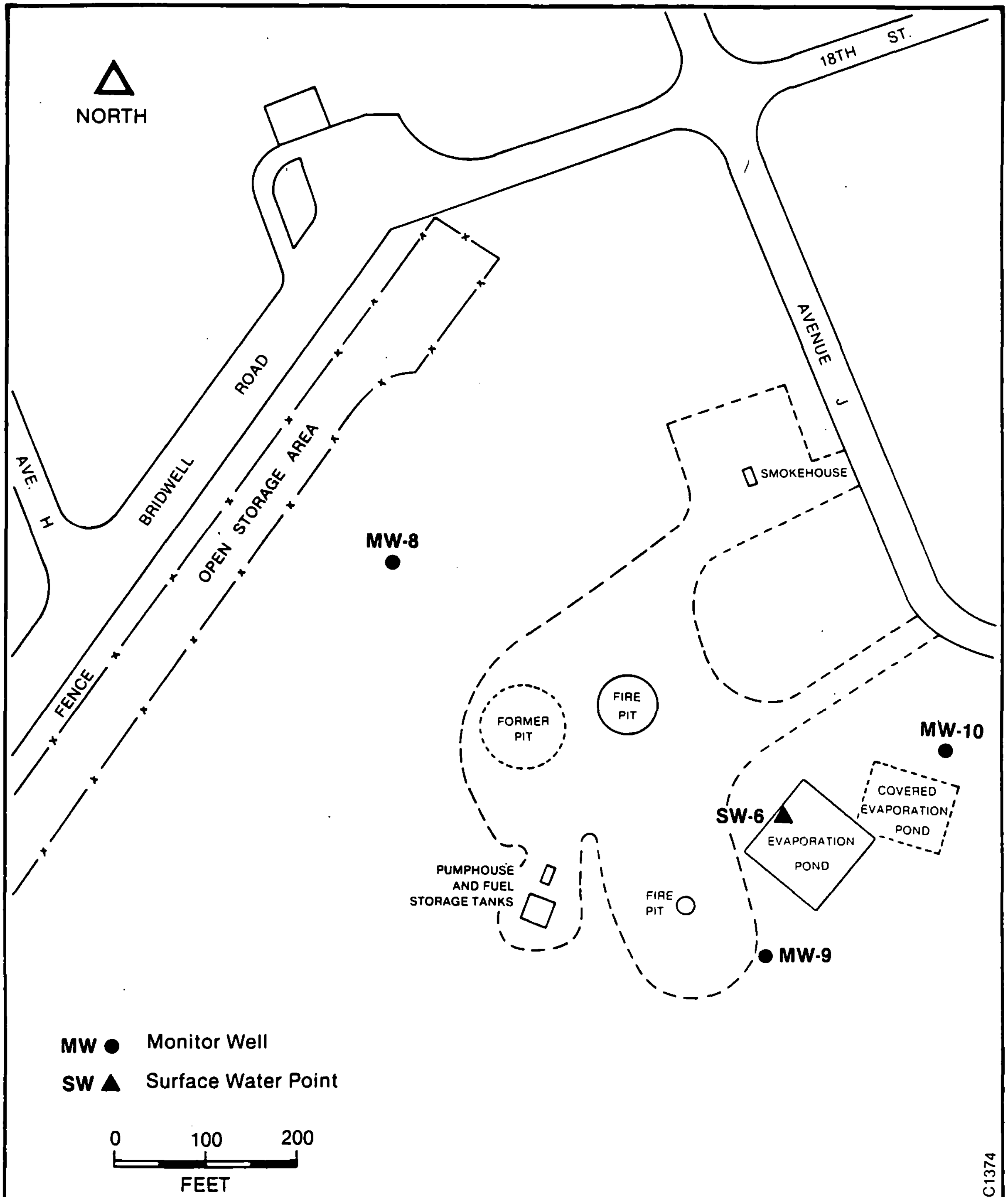

FIGURE 4-15. MONITOR WELL LOCATIONS AND SURFACE WATER CONTROL POINTS, VICINITY FIRE PROTECTION TRAINING AREA NO. 3, SHEPPARD AFB, TX.

June 1986

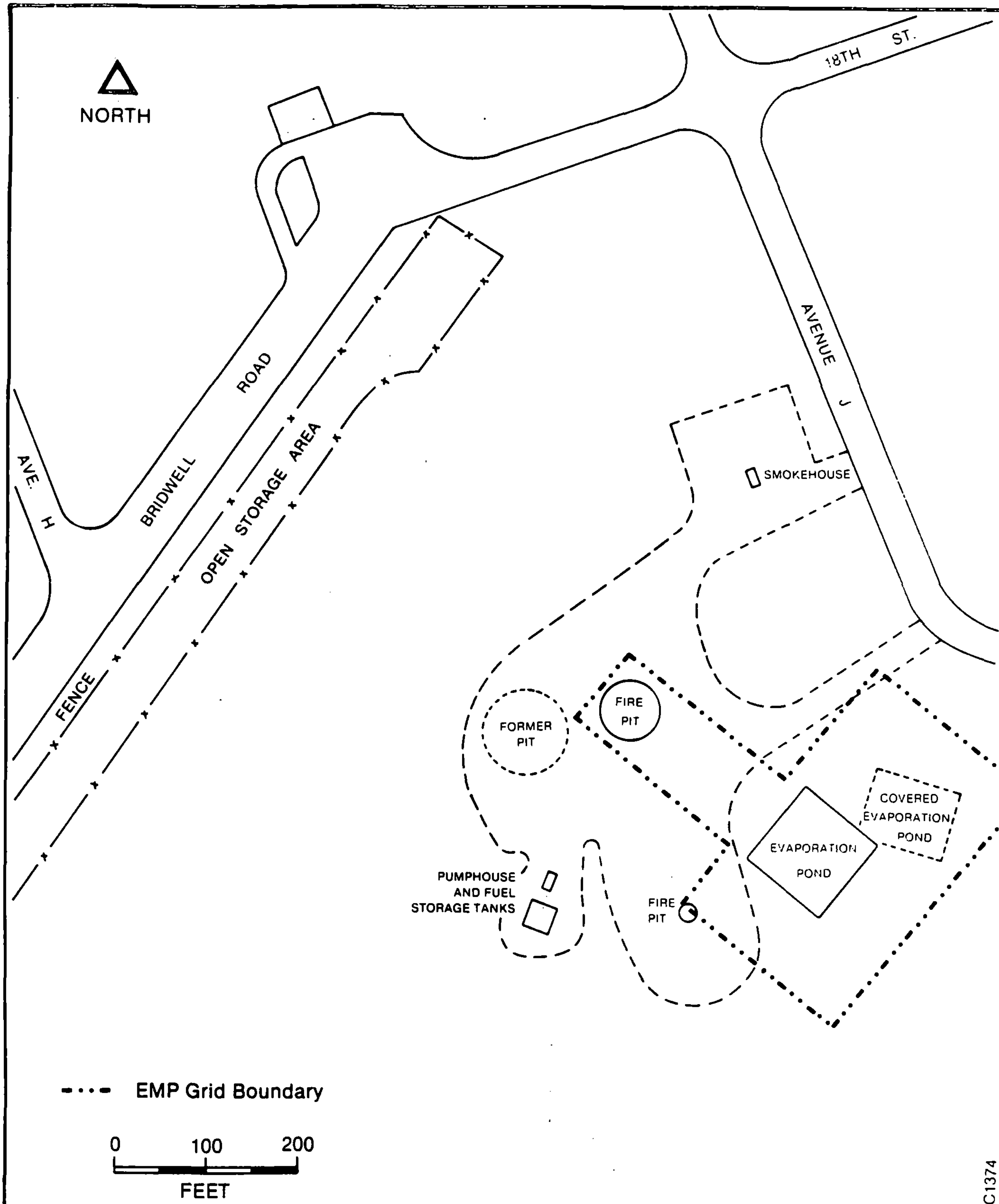

FIGURE 4-16. GENERAL LOCATION OF ELECTROMAGNETIC GRID AT FIRE TRAINING AREA NO. 3, SHEPPARD AFB, TX.

June 1986

Due to the large amount of utilities and equipment associated with the training activities, particularly in the northern grid, the data are somewhat erratic and not reliable. However, there is a general trend of increasing conductivity toward the evaporation pond which correlated well with data from the southern section around the pond. The contour areas of about 125 umhos represent higher concentrations which contrasted with natural materials outside of the training area. Conductivity highs on both the east and west sides of the pond may be due to contamination or to saturated materials. Of particular interest are the high readings on the east side of the pond which is the general area of an older evaporation pond which was filled in when the present facility was built. Readings outside of the 125 umhos readings area are generally lower and more indicative of sandier soils. Figure 4-17 shows data from the EM-31 survey. All other geophysical figures are provided in Appendix L.

Occurrence of Ground Water

Three locations were drilled in order to detect any local ground water. Upon completion of the borings, Monitor Wells were installed (Figure 4-15). All locations drilled had ground water and ranged in depth from 30 to 35 feet. They were drilled in areas where the dominant materials encountered were sands, silts and clays. Two cross sections were constructed along lines at the site and are shown on Figure 4-18. The sections on Figure 4-19 traces the generalized logs of the monitor wells along with water-level data. Figure 4-20 is a map of surface water elevations and ground-water level contours. The general direction of ground-water flow is to the southeast from high ground-water elevations to lower elevations. The detailed information on the logs and monitor well completion are provided in Appendix D.

Ground Water Quality

The monitor wells were sampled after they were completed. Sampling activities were difficult due to extremely cold weather and low productivity

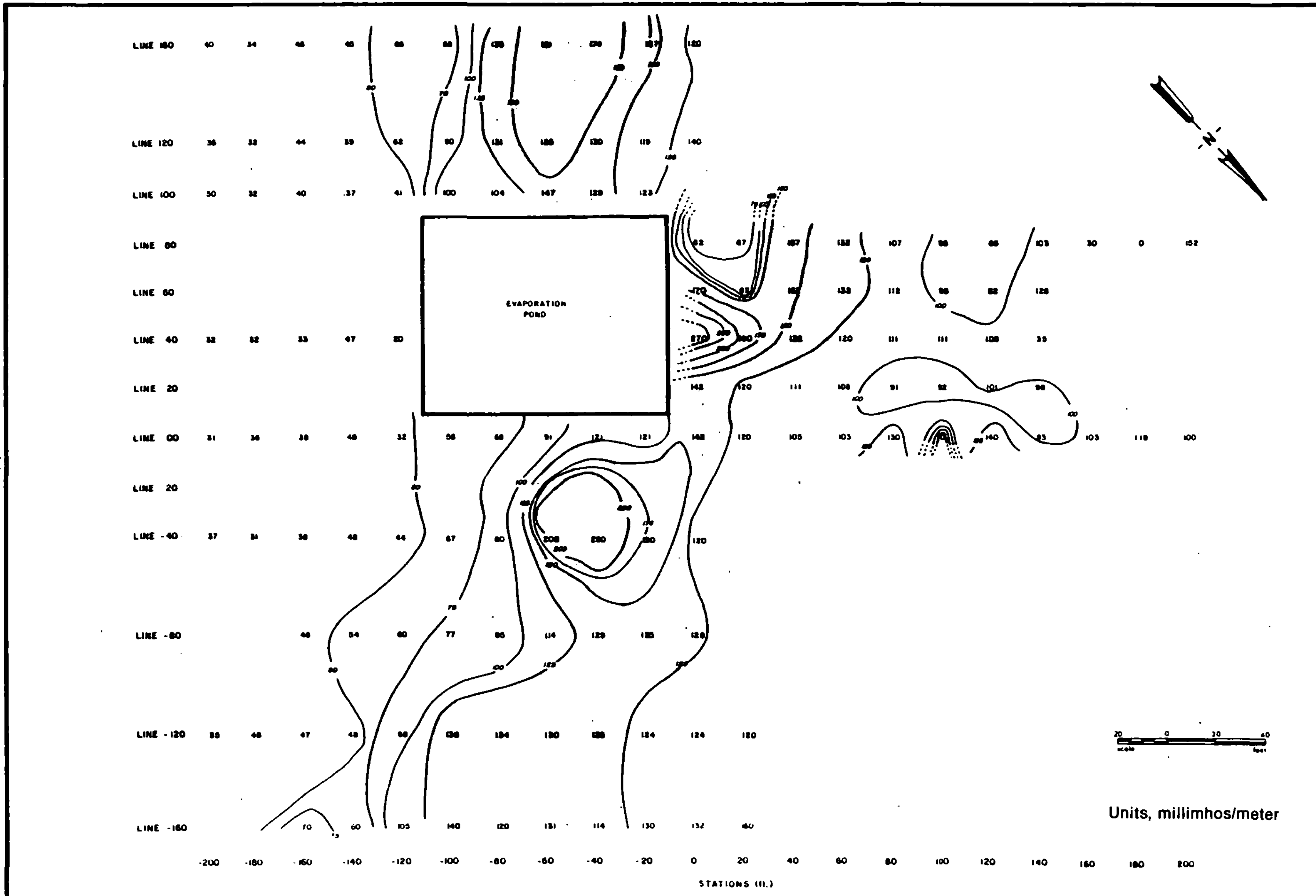

FIGURE 4-17. RESULTS OF EM SURVEY, VICINITY OF FIRE PROTECTION TRAINING AREA NO. 3, SHEPPARD AFB, TX.

June 1986

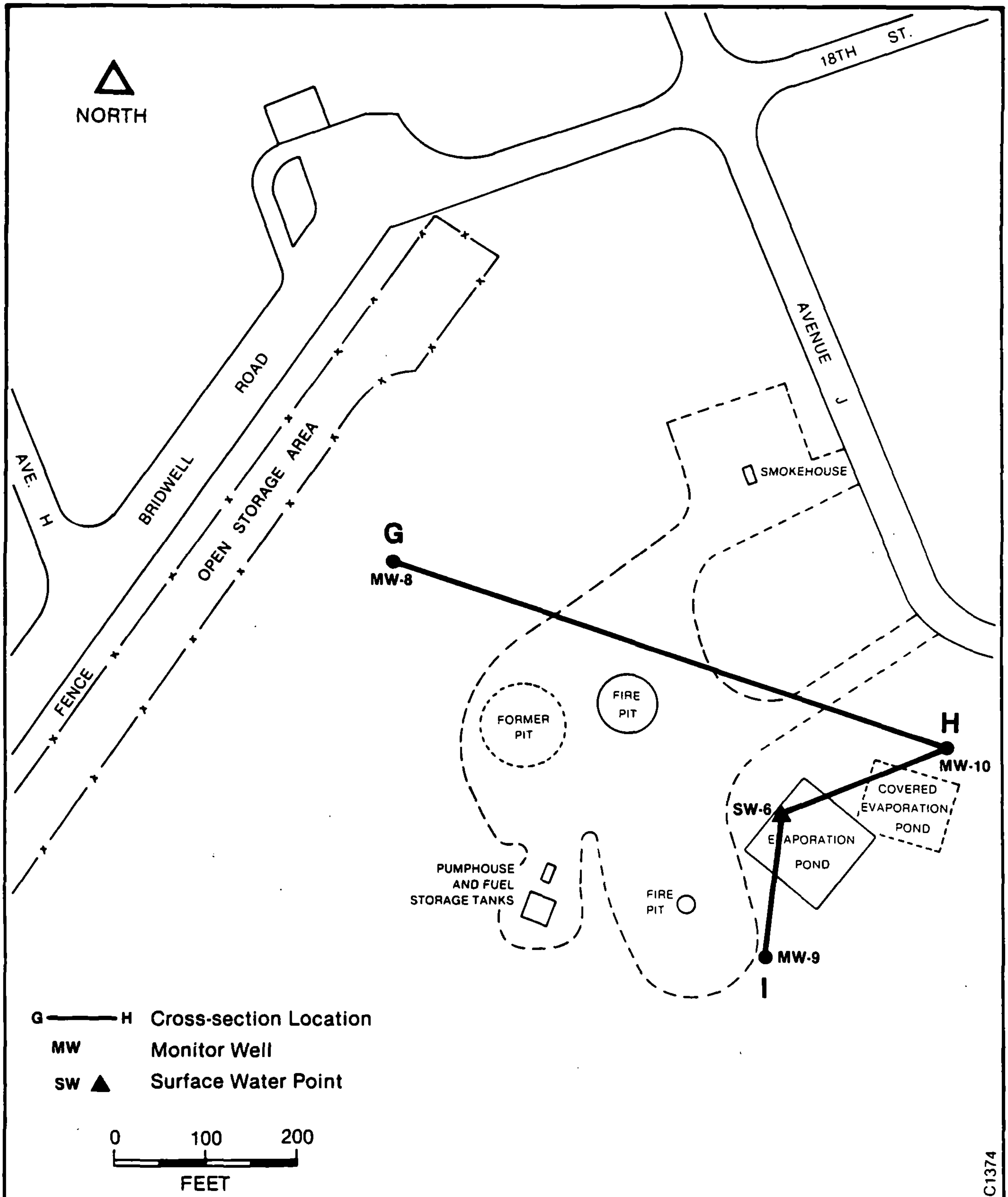

FIGURE 4-18. GENERAL CROSS SECTION LOCATIONS AT FIRE TRAINING AREA NO. 3, SHEPPARD AFB, TX.

June 1986

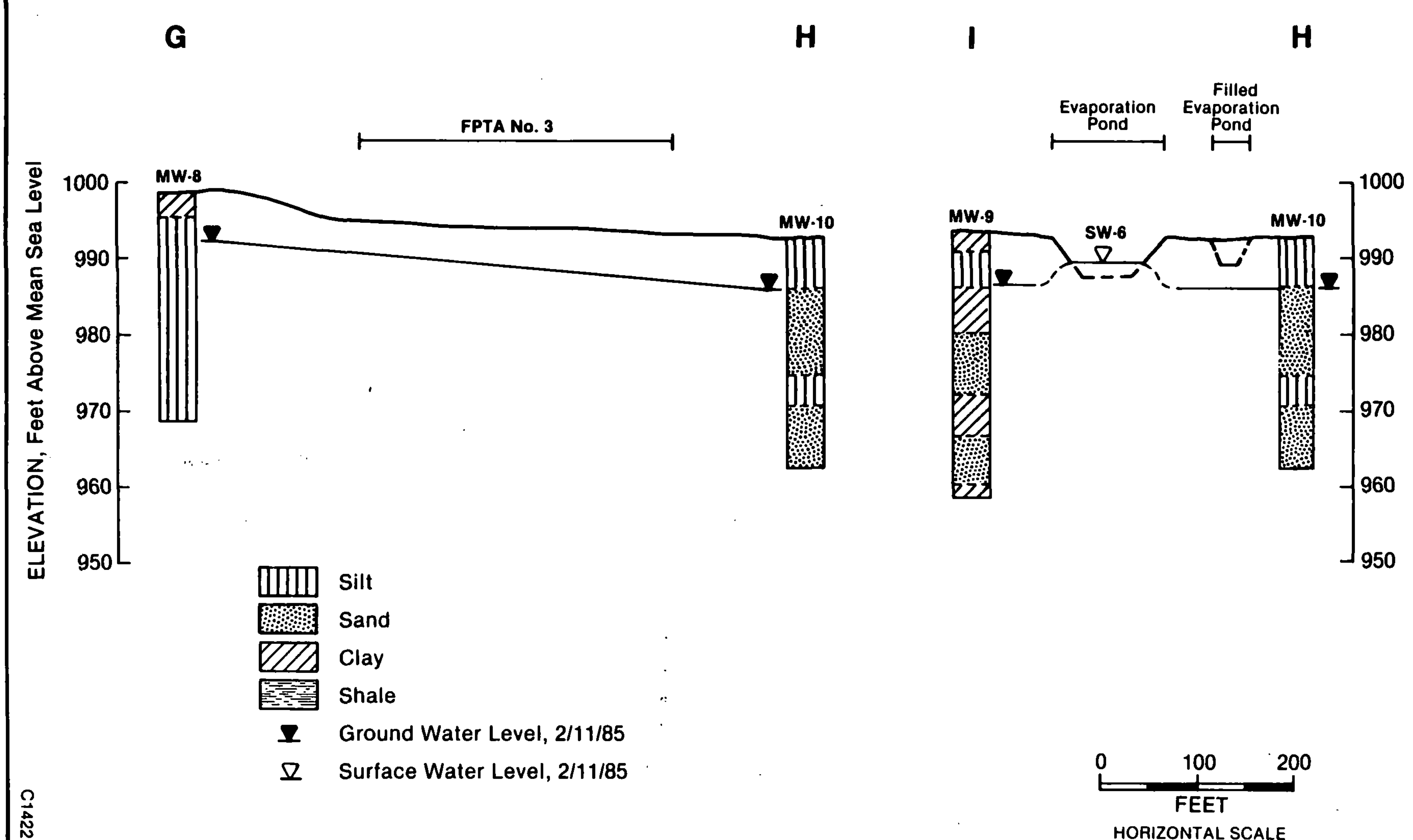

FIGURE 4-19. GENERAL HYDROGEOLOGIC CROSS SECTIONS G-H AND I-H VICINITY OF FIRE PROTECTION TRAINING AREA NO. 3, SHEPPARD AFB, TX.

June 1986

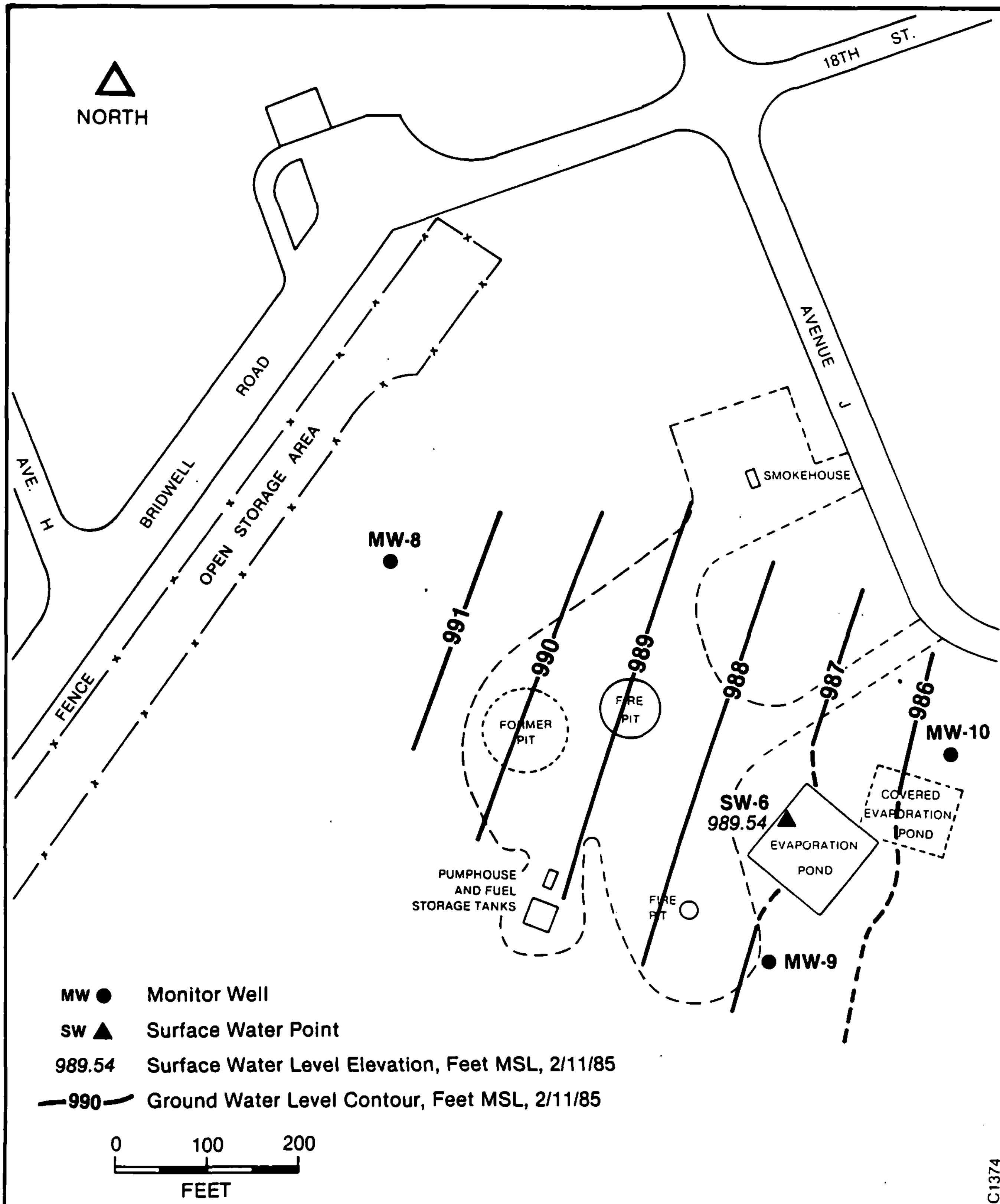

FIGURE 4-20. WATER LEVEL ELEVATION AND CONTOURS VICINITY FIRE PROTECTION TRAINING AREA NO. 3, SHEPPARD AFB, TX.

June 1986

of the monitor wells. The analytical results of the inorganic parameters are shown on Table 4-10. Those for organic compounds detected are summarized on Table 4-11. The analytical results are provided in Appendix H. A number of organic solvent compounds were detected in the ground water in the upgradient and downgradient monitor wells. Additional discussion follows in the significance of findings.

Surface Water

Surface-water samples were collected from the evaporation pond. Surface water station SW-6 is shown on Figures 4-15 and 4-20. Results of the analyses are shown on Tables 4-10 and 4-11. The complete analytical data are provided in Appendix H. Two organic compounds were detected in the pond water. The significance of these data are provided in the following subsection.

Other Samples

A composite sample was obtained from the barrelled cuttings at the monitor well No. 9 location. Hydrocarbon odors were detected when the monitor well was being drilled. Therefore, a composite sample was obtained from the barreled cuttings and submitted for EP toxicity and ignitability analyses. No parameters analyzed exceeded the EP toxicity guide, and the ignitability was well above the flash point guide of 140°F.

4.4.2 Significance of Findings

The investigations at Fire Protection Training Area No. 3 were designed to confirm any presence of leachate contamination in the subsurface. The geophysical results show two anomalous areas: one northeast of the present evaporation pond (Figure 4-17) and near the former, now-filled, evaporation pond and MW-10 (Figure 4-20), and the other southwest of the evaporation pond close to MW-9. Southeast of the evaporation pond the

TABLE 4-10. RESULTS OF WATER ANALYSES, FPTA NO. 3, SHEPPARD AFB, TX

SAMPLE LOCATION	BASE SAMPLE NUMBER AND DATE OF COLLECTION (1)	TOC (mg/L)	OIL & GREASE (mg/L)	TDS (mg/L)	pH (pH units)	LEAD (mg/L)	CHROMIUM (mg/L)	MERCURY (mg/L)
EVAPORATION POND								
SW-6	840193 (12/12/84)	180	10	1,000	7.72	0.004	-	-
	850005 (02/15/85) *	130	2	330	6.77	0.005	-	0.0004
GROUND WATER								
MW-8	850009 (02/07/85)	45	-	9,100	7.48	0.009	0.041	0.0014
	850018 (02/14/85) *	44	-	1,200	7.53	-	0.016	0.0014
MW-9	850006 (02/07/85)	230	7	1,500	7.97	0.013	-	0.0007
	850019 (02/15/85) *	43	-	7,800	7.59	-	-	0.0012
MW-10	850007 (02/07/85)	49	1	2,700	7.97	0.058	0.009	0.0015
	850020 (02/14/85) *	66	-	12,000	7.45	-	-	0.0014

(1) Date of collection is expressed as (Month/Day/Year).
* Asterisk denotes second round of sampling.
\- Denotes parameter not detected.

TABLE 4-11. ORGANIC COMPOUNDS DETECTED IN WATER, FIRE PROTECTION TRAINING AREA (FPTA) NO. 3, SHEPPARD AFB, TX

SAMPLE LOCATION	BASE SAMPLE NUMBER AND DATE OF COLLECTION (1)	1,1,1-TRI-CHLORO-ETHANE (ug/L)	TRICHLORO-ETHYLENE (2) (ug/L)	TETRACHLORO-ETHYLENE (ug/1)	BENZENE (ug/L))	TOLUENE (ug/L)	ETHYL BENZENE (ug/L)
EVAPORATION POND							
SW-6	840193 (12/12/84)	- (3)	-	-	-	-	-
	850005 (02/07/85) *	-	-	-	10.0 (4)	2.8 (4)	-
GROUND WATER							
MW-8	850009 (02/07/85)	9.0 (4)	1.5 (4)	1.3 (4)	-	-	-
	850018 (02/14/85) *	7.5 (4)	-	-	-	-	3.4 (4)
MW-9	850006 (02/07/85)	-	4.0 (4)	4.1 (4)	-	-	-
	850019 (02/15/85) *	-	-	-	-	-	-
MW-10	850007 (02/07/85)	-	4.0 (4)	3.9 (4)	-	-	-
	840020 (02/14/85) *	-	-	3.9 (4)	-	18.3 (4)	24.9 (4)

(1) Date of collection is expressed as (Month/Day/Year).
(2) Also known as Trichloroethene.
(3) - denotes Not Detected.
(4) Compound identity not confirmed by second GC column. Therefore, this result may not be valid.
* Asterisk denotes second round of sampling.

electromagnetic readings were all low. Northwest of the pond the data is erratic due to the large amount of utilities and training equipment in this immediate area.

The results of ground-water analyses indicate the presence of inorganic and organic compounds (Tables 4-10 and 4-11). Table 4-12 shows all compounds detected which exceed federal and/or state regulations and guidelines. Monitor Well MW-8 and MW-10 had the majority (4 of 7) of organic compounds (Table 4-11) detected followed by Monitor Well MW-9. Monitor Well MW-10 also had the highest lead concentration, which was found only during the first sampling round. Since the lead value at MW-10 is barely above the guideline considered, and only exceeded during one of the sampling rounds, its significance would not appear to be as great. This is because a number of factors can affect the detection of trace metals. These factors can be natural such as seasonal and local weather conditions, as well as fire training area activities and analytical variations.

The static water levels of the three monitor wells indicate that the ground water flows to the southeast. The discovery of low levels of synthetic organic compounds at Monitor Well MW-8 upgradient of the site suggests a different source of contamination. Possible sources could be the open storage area and Bridwell road to the east (Figure 4-20). However, seasonal ground water flow directions are unknown. The probability of off-Base migration of these compounds is small since the Base boundary is 4,500 feet away in a southeasterly direction. However, ground-water flow directions at greater distances from the site are unknown. Since Base water is supplied from off-Base sources, there is no threat to the health of Base personnel.

The reason that MW-10 had more organic compounds detected than MW-9 may be attributed to its proximity to the former evaporation pond. It is possible that chemicals which were detected in Monitor Well MW-10 may be leaching out of the old evaporation pond. Another possibility is that the

TABLE 4-12. FIRE PROTECTION TRAINING AREA (FPTA) NO. 3, SUMMARY OF GROUND WATER ANALYTE RESULTS EXCEEDING FEDERAL AND/OR STATE REGULATIONS OR GUIDELINES

SAMPLING SITE		ANALYTE AND RESULTS (1) TOTAL DISSOLVED SOLIDS (S) (mg/L)	LEAD (P) (mg/L)	BENZENE (ug/L)
	GUIDELINE (2)	500 (3) [1,000]	0.05	6.6 (4)
SURFACE WATER				
SW-6		1,000	- (5)	-
		- *	-	10.0 (6)
GROUND WATER				
MW-8		9,100	-	-
		1,200 *	-	-
MW-9		1,500	-	-
		7,800 *	-	-
MW-10		2,700	0.058	-
		12,000 *	-	-

(1) Federal and State of Texas primary and secondary drinking water standards denoted by (P) and (S), respectively. Secondary criteria based upon aesthetics for water consumption while primary criteria are based upon health considerations. Regulatory references: Federal Register, 24 October 1980 and 7 September 1979; Texas Department of Health drinking water standards, revised 1 November 1980.
(2) [] denotes State of Texas criteria which is different from Federal criteria.
(3) Guideline concentration in ug/L, analytical results in (mg/L).
(4) EPA has recommended human health effects criteria of zero for carcinogens, but notes that this level may currently be nonfeasible. The Agency provides criteria for achieving various levels of protection on an interim basis. The levels which may result in a 0.00001 incremental increase of cancer risk over a lifetime are presented in ppb, analytical results are in (ug/L). (Federal Register, Friday, 28 November 1980.)
(5) - denotes that guidelines were not exceeded.
(6) Compound identity not confirmed by second GC column. Therefore, this result may not be valid.
* Asterisk denotes results from the second round of sampling.

compounds are migrating from the old unlined fire training pits which were essentially directly upgradient from Monitor Well MW-10.

EPA Method 602 compounds were not prevalent in the analytical results. These compounds would normally be expected as part of waste fuels used in fire protection training. The analytical chromatographs indicated interferences that probably masked the aromatic compounds (EPA 602) results where the samples had to be analyzed at a 1/50 dilution ratio. The dilution raised the detection limit by a factor of 50.

Although local ground-water flow directions at FPTA No. 3 are in a southeasterly direction, the influence of nearby underground utilities is unknown. For instance, a storm drain is located under the site which could provide ground-water recharge or discharge to off-base areas. Correspondingly, contaminants which are transported during a storm could leak into the local ground-water system.

The results of evaporation pond analyses indicate the presence of inorganic and organic compounds shown on Tables 4-10 and 4-11. Table 4-12 shows the compounds (one benzene sample, one lead sample and all total dissolved solids) exceeding Federal and/or State regulations and guidelines. Benzene, an organic compound, and lead exceeded a criterion based upon health considerations. Total dissolved solids exceeded a criteria based upon drinking water aesthetics, and high TDS is a natural characteristic of surface and groundwater in the area. Further, both parameters exceeded a criteria from only one round of sampling. A number of factors can affect the detection of these compounds; particularly since the sample is obtained from a surface water pond. These factors can be local weather conditions, analytical variations and fire training area activities. The static water levels of the evaporation pond and the monitor wells (see Figures 4-19 and 4-20) indicate that chemicals in the unlined evaporation pond can migrate into the subsurface and to the ground water.

The significant findings are summarized below:

- o Ground water was confirmed and a southeasterly flow direction determined;

- o No direct geophysical evidence of a contaminant leachate plume was found, although an anomaly in the area of the old evaporation pond was detected;

- o Two inorganic parameters (Pb and TDS) were detected in the ground water and one organic compound was detected in surface water in concentrations exceeding Federal and/or State regulations and guidelines; and

- o Organic compounds were detected in the upgradient monitor well.

4.5 Fire Protection Training Area (FPTA) No. 1

The work performed at FPTA No. 1 consisted of conducting an electromagnetic (EM) survey followed by the installation of four ground-water monitoring wells. The monitor wells were subsequently sampled for chemical analyses. Four surface water control points were established at the nearby ponds and creek areas to obtain surface water samples for chemical analyses. Four locations were selected for hand augering and the collection of soil samples. The results and significance of the hydrogeologic and chemical data are discussed in the following paragraphs.

4.5.1 Results of Investigation

Topography

FPTA No. 1 is located beneath the present Base golf course Green No. 2 (Figure 4-21). The old training site is no longer visible. The land surface is gently rolling, sloping to the northwest and west toward an unnamed tributary of Plum Creek. The general relief at the golf course is about 45 feet ranging in elevation from 980 to 1,025 feet. The site specific relief is in the order of 25 feet ranging from 1,000 to 1,025 feet.

Geologic Features

The geologic features of the study site observed during the drilling activities were consistent with the regional geologic setting of the Wichita Falls area and the known geologic conditions at Sheppard AFB.

The principal materials encountered at the site were near-surface layers of clay or silt underlain by weathered to consolidated sand. Clay was found below the sand at about 982 msl feet.

Geophysical Surveys

The primary geophysical technique used at FPTA No. 1 was electromagnetics (EM). EM-31 and EM-34 instruments were used to profile the study site. A rectangular grid of 200 feet by 300 feet was flagged around the suspected site (Figure 4-22). The grid was offset to the site due to adjacent gas and water lines on the west side which would adversely affect EM readings. Several lines were extended to 500 feet to obtain closure of an anomalous zone. Point station measurements were taken at every 25 feet. At each station, geophysical data was obtained from depths of approximately 10, 20, and 45 feet. Using these three data sets, vertical as well as lateral changes in conductivity were evaluated.

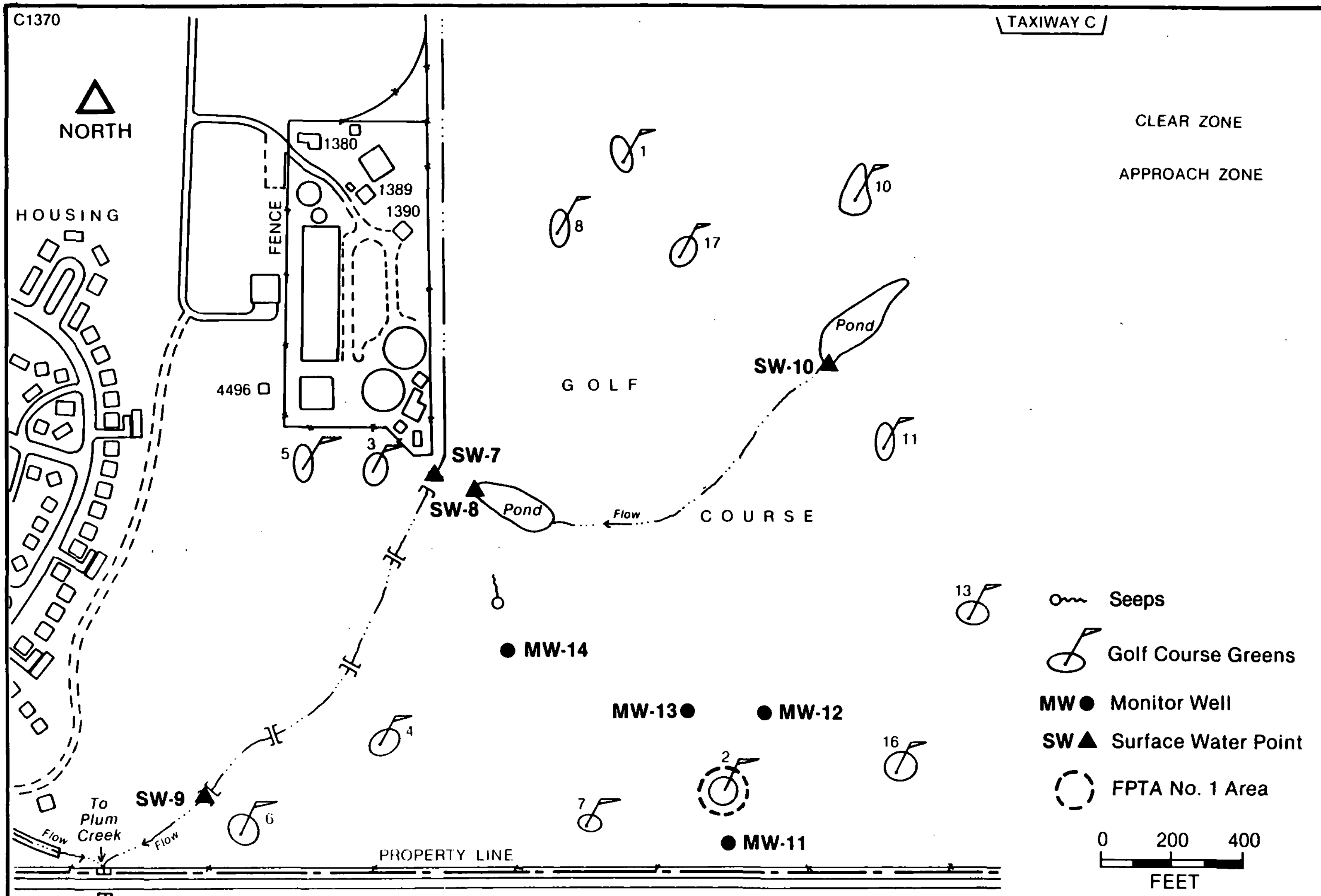

FIGURE 4-21. LOCATIONS OF MONITOR WELLS AND SURFACE WATER CONTROL POINTS, VICINITY OF FIRE PROTECTION TRAINING AREA NO. 1, SHEPPARD AFB, TX.

June 1986

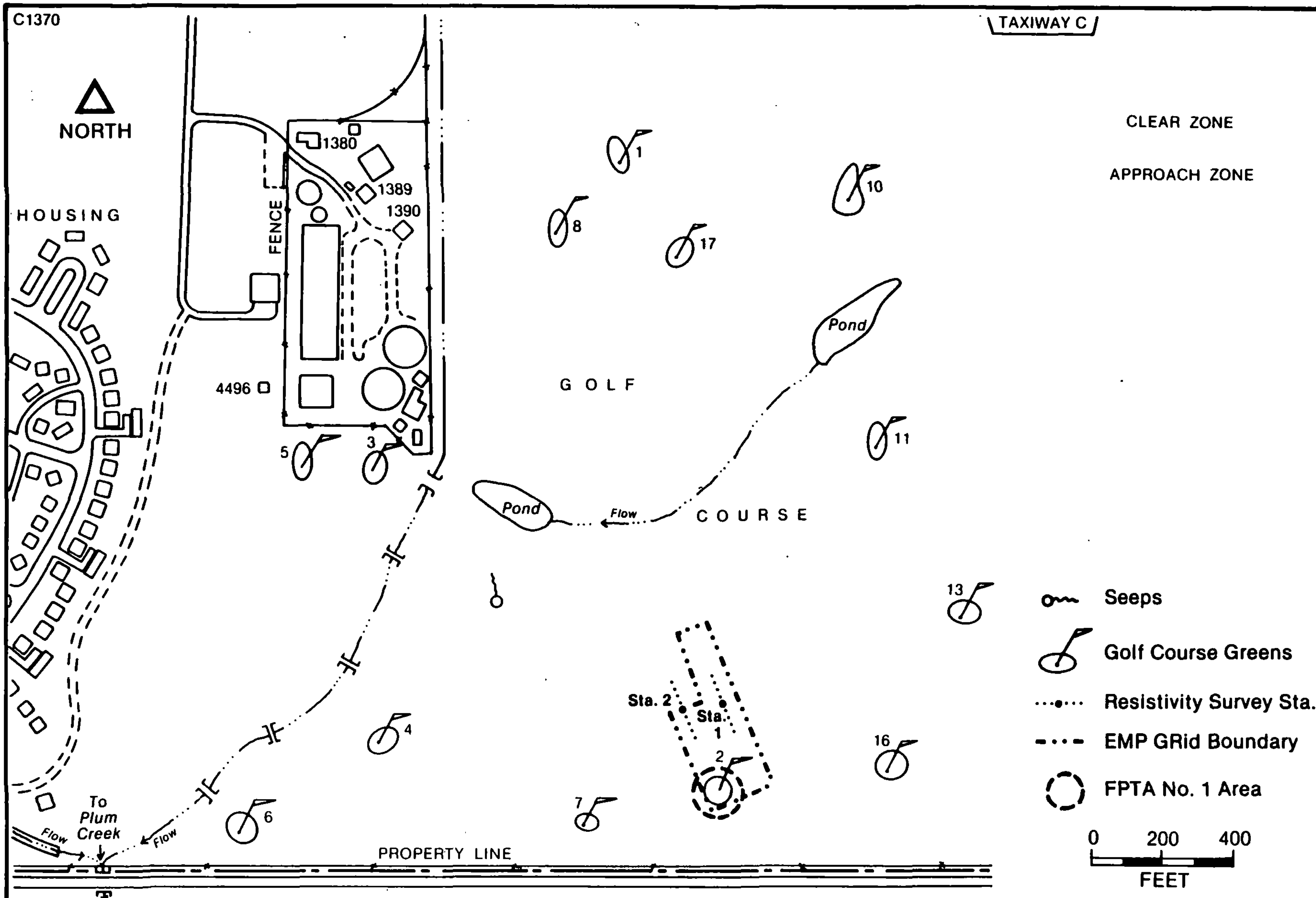

FIGURE 4-22. GENERAL LOCATION OF ELECTROMAGNETIC GRID AND RESISTIVITY SURVEY POINTS AT FIRE TRAINING AREA NO. 1, SHEPPARD AFB, TX.

June 1986

Electromagnetic measurements indicated higher conductivity values north of the Green No. 2 (Figure 4-23). The shaded portion of the figure represents conductivity values greater than 50 umhos. These values can be indicative of contamination but are more likely reflective of the clayey material. Additionally, features associated with the golf course, such as irrigation lines and sprinkler systems, may influence the EM readings. Although these features exist in the area, the high EM values do not correlate well with any of them, and the anomaly shows increasing conductivity with depth which is not normally expected from a shallow, highly localized source. The generally lower conductivity values found in the area, which also indicate a somewhat permeable soil, suggest that this anomaly may be due to subsurface contamination. The old training site was not evident from the geophysical data. The remaining EM profiles are provided in Appendix L.

Two reconnaissance resistivity soundings were conducted at the site. The purpose was to define a sandstone stratum which had been reported to underlie the site. The sandstone could have been an augering problem, and knowledge of its depth would aid in monitor well installation planning. The resistivity locations are depicted on Figure 4-22. The results of the soundings were not conclusive due to the number of golf course features and ground inhomogeneity. Resistivity values were determined to be about 6 to 8 ohm-meters which indicates relatively conductive material. In this case, the material appeared to be near-surface clays.

Occurrence of Ground Water

Four locations (Figure 4-21) were drilled in order to detect ground water, with the subsequent installation of monitor wells when ground water was encountered. The monitor well borings ranged in depth from 18 to 30 feet where the dominant material encountered was weathered to consolidated sands. Clay was encountered at Monitor Well MW-12 and MW-14 at about 23 and 18 feet, respectively. Two cross sections were developed (Figure 4-24) to study ground water and surface water relationships and the potential for contaminant flow.

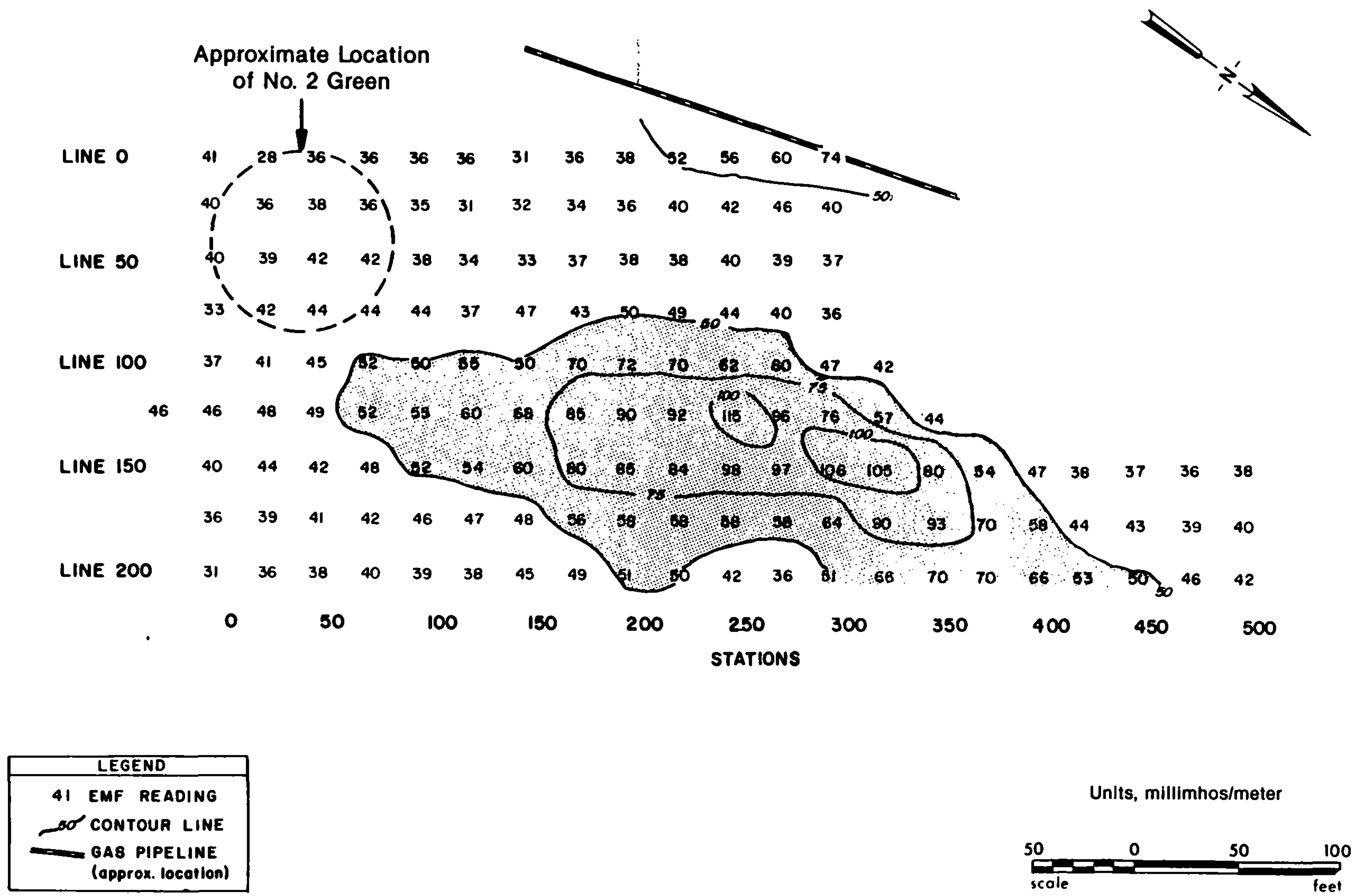

FIGURE 4-23. RESULTS OF EM SURVEY VICINITY OF FIRE PROTECTION TRAINING AREA NO. 3, SHEPPARD AFB, TX.

June 1986

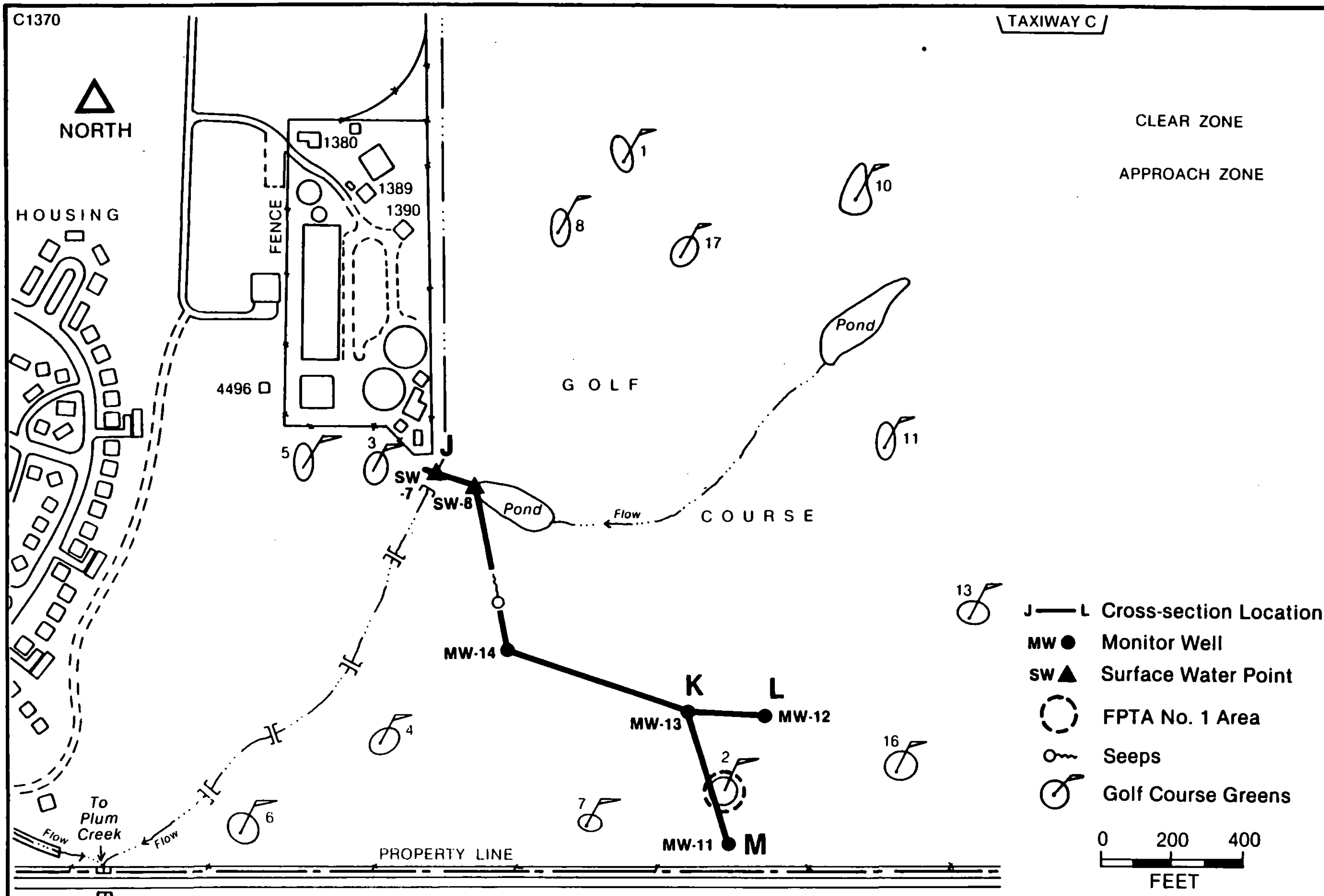

FIGURE 4-24. GENERAL CROSS SECTION LOCATION AT FIRE PROTECTION TRAINING AREA NO. 1, SHEPPARD AFB, TX.

June 1986

Two hydrogeologic profiles (Figure 4-25) illustrate the subsurface conditions along with water level data. During the drilling, ground water was first detected from 15 to 25 feet below ground level. Figure 4-26 is a contour map of ground-water elevations. The surface water elevation of SW-10 was not surveyed and is noted by NA (not applicable) in Figure 4-26. The detailed information on the logs and monitor well completion are provided in Appendix D.

The results of the drilling activities and field observations (i.e., outcrops at stream banks) indicated that water-table conditions exist very near the ground surface. Depths to ground water in the completed monitor wells ranged from 0.4 to 6.3 feet below ground level. The ground water flows northward toward the nearby golf course ponds and creek. In some areas it surfaces as it seeps, such as downslope of Monitor Well MW-14 (Figure 4-26).

Ground Water Quality

Ground-water sampling activities were difficult due to extremely cold weather. Inorganic results from FPTA No. 1 are shown on Table 4-13; organic compounds detected are summarized on Table 4-14. All analytical results are provided in Appendix H. Additional information is provided in paragraph 4.5.2, Significance of Findings.

Surface Water

Surface water samples were also collected at four locations (Figure 4-21). Surface water points SW-7, SW-8 and SW-9 were used for field data collection and sampling for laboratory chemical analyses. Location SW-10 was used for field data collection and comparison only to the other surface water samples. This sample was to see if any gross contamination was draining off the flightline area which could influence downstream measurements. The SW-10 field measurements were 7.0°C, 220, and 6.8 for temperature, conductivity, and

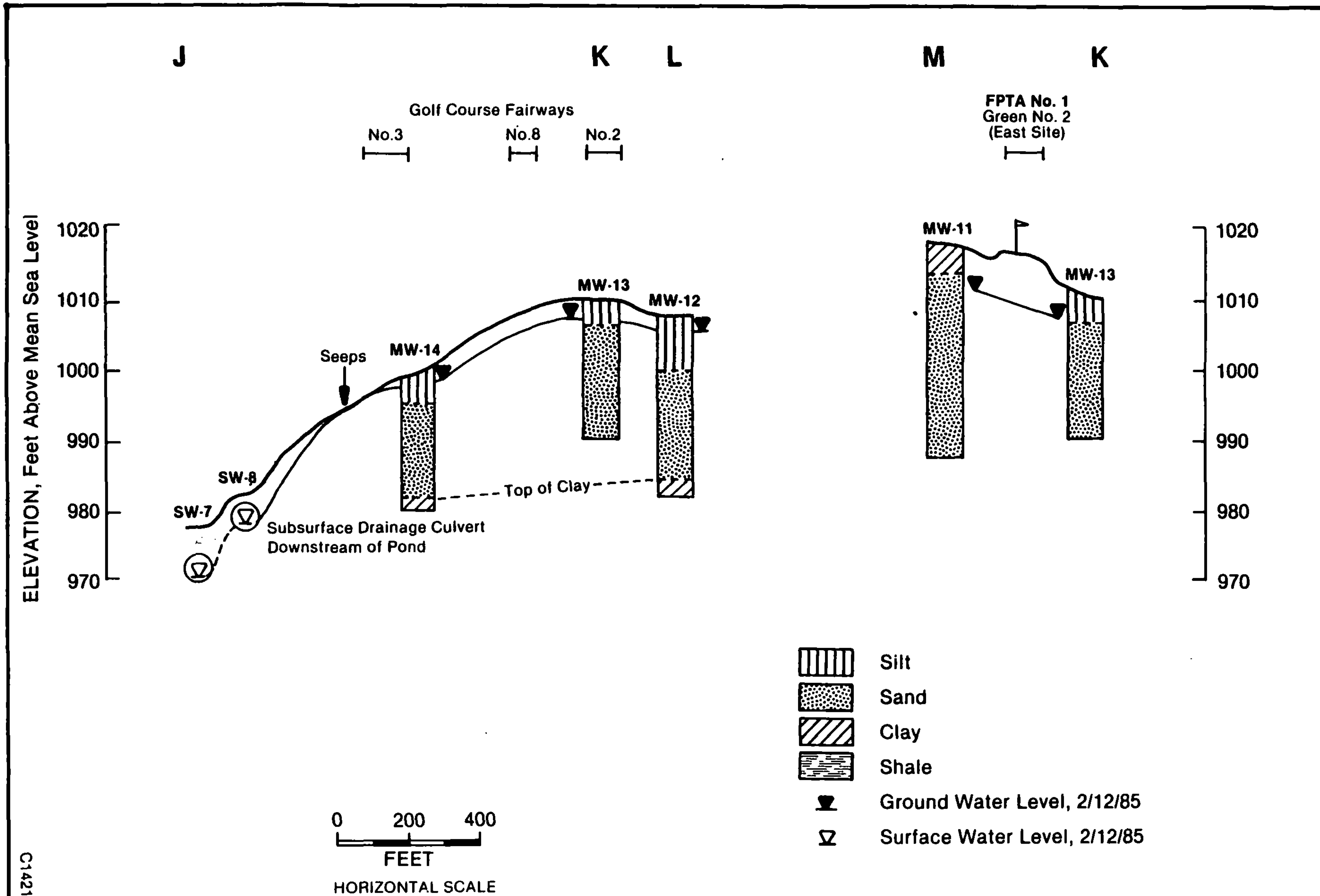

FIGURE 4-25. GENERALIZED HYDROGEOLOGIC PROFILE J-L AND M-K VICINITY OF FIRE PROTECTION TRAINING AREA NO. 1, SHEPPARD AFB, TX.

June 1986

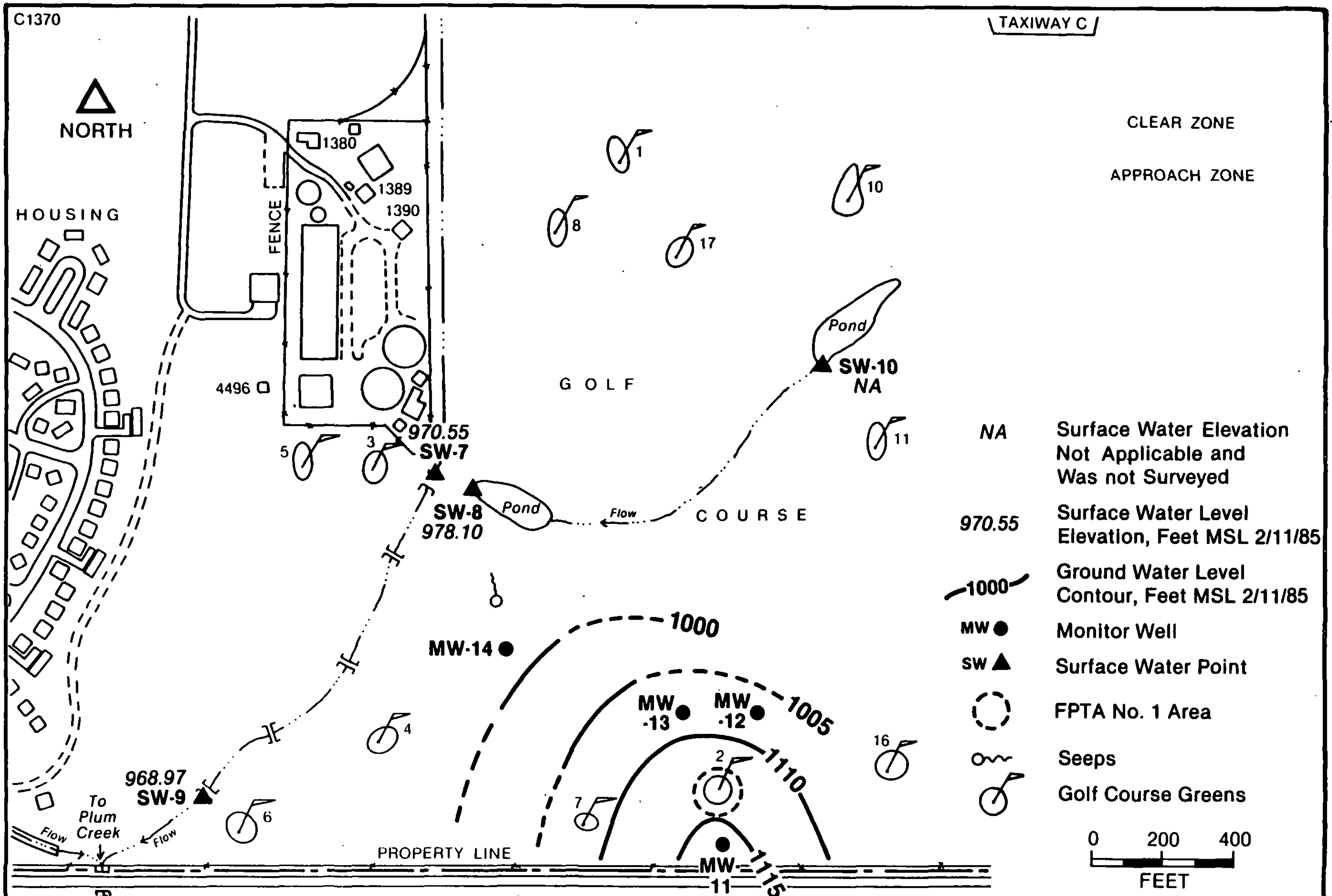

FIGURE 4-26. WATER LEVEL ELEVATIONS AND CONTOURS VICINITY FIRE PROTECTION TRAINING AREA NO. 1, SHEPPARD AFB, TX.

June 1986

TABLE 4-13. RESULTS OF WATER ANALYSES, FIRE PROTECTION TRAINING AREA (FPTA) NO. 1, SHEPPARD AFB, TX

SAMPLE LOCATION	BASE SAMPLE NUMBER AND DATE (1)	PHENOL (mg/L)	TOC (mg/L)	OIL & GREASE (mg/L)	TDS (mg/L)	pH (pH units)
SURFACE WATER						
SW-7	840194 (12/12/84)	0.07	10	5	1,400	8.00
	850021 (02/13/85) *	0.16	42	1	1,800	8.54
SW-8	840195 (12/12/84)	<0.01	8	3	270	8.17
	850073 (02/13/85) *	0.038	11	-(2)	950	8.03
SW-9	840196 (12/12/85)	0.03	20	9	310	7.36
	850074 (02/13/85) *	0.041	25	-	760	7.52
GROUND WATER						
MW-11	850001 (02/05/85)	0.072	94	6	530	6.70
	850075 (02/13/85) *	0.091	22	-	480	7.53
MW-12	850002 (02/05/85)	0.072	40	6	850	6.64
	850076 (02/13/85) *	0.086	23	1	760	7.34
MW-13	850003 (02/05/85)	0.029	51	6	1,200	6.57
	850077 (02/13/85) *	0.065	23	-	1,200	7.05
MW-14	850004 (02/05/85)	0.026	22	5	1,900	6.80
	850078 (02/13/85) *	0.022	13	-	1,800	7.09
MW-14 QC	850079 (02/13/85) *	0.083	15	-	1,700	7.09

(1) Date of collection is expressed as (Month/Day/Year).
(2) - denotes Not Detected.
* Asterisk denotes second round of sampling.

TABLE 4-14. ORGANIC COMPOUNDS DETECTED IN WATER, FIRE PROTECTION TRAINING AREA (FPTA) NO. 2, SHEPPARD AFB, TX

SAMPLE LOCATION	BASE SAMPLE NUMBER AND DATE (1)	METHYLENE-CHLORIDE (ug/L)	TRICHLORO-FLUORO-METHANE (ug/L) (2)	CHLOROFORM (ug/L)	BROMODI-CHLORO-METHANE (ug/L)	DIBROMO-CHLORO-METHANE (ug/L)	1,2-DICHLORO-ETHANE (ug/L)	1,1,1-TRI-CHLORO-ETHANE (ug/L)	TRICHLORO-ETHYLENE (3) (ug/L)	TETRA-CHLORO-ETHYLENE (ug/L)
SURFACE WATER										
SW-7	840194 (12/12/84)	- (4)	0.8 (5)	-	-	-	-	-	-	-
	850021 (02/13/85) *	-	-	-	-	-	-	-	-	-
SW-8	840195 (12/12/84)	-	2.0 (5)	-	-	-	-	-	-	-
	850073 (02/13/85) *	-	-	-	-	-	-	-	-	-
SW-9	840196 (12/12/84)	-	0.9 (5)	-	-	0.5 (5)	-	-	-	-
	850074 (02/13/85) *	7.1 (5)	-	3.9 (5)	3.9 (5)	-	-	-	-	-
GROUND WATER										
MW-11	850001 (02/05/85)	-	-	2.0 (5)	-	-	-	-	1.5 (5)	2.5 (5)
	850075 (02/13/85) *	-	-	-	-	-	-	-	-	-
MW-12	850002 (02/05/85)	-	-	2.9 (5)	-	-	2.8 (5)	-	5.5 (5)	1.9 (5)
	850076 (02/13/85) *	-	-	4.7 (5)	-	-	4.0 (5)	-	10.3 (5)	-
MW-13	850003 (02/05/85)	-	-	-	-	-	-	-	1.2 (5)	1.4 (5)
	850077 (02/13/85) *	-	-	-	-	-	-	-	-	3.8 (5)
MW-14	850004 (02/05/85)	-	-	-	-	-	-	1.7 (5)	1.2 (5)	1.5 (5)
	850078 (02/13/85) *	-	-	-	-	-	-	-	-	-
MW-14 QC	850079 (02/13/85) *	-	-	-	-	-	-	-	-	-

(1) Date of Collection is expressed as (Month/Day/Year).
(2) Trichlorofluoromethane deleted from toxic pollutants list 1981.
(3) Also known as Trichloroethene.
(4) - denotes Not Detected.
(5) Compound identity not confirmed by second GC column. Therefore, this result may not be valid.
* Asterisk denotes second round of sampling.

pH respectively. This water was comparable or better in quality than the downstream waters.

Results of the chemical analyses are shown on Tables 4-13 and 4-14. The raw analytical data are provided in Appendix H. The presence of phenols and oil and grease were detected in the surface water samples which is discussed further under Significance of Findings.

Other Samples

Four locations (Figure 4-27) were selected for hand augering to visually confirm FPTA No. 1. The hand augerings ranged in depth from 3.0 to 4.0 feet. Water was encountered in three of the holes (C-5, -6, and -7). Corehole C-4 was placed immediately next to Green No. 2 at the probable location of FPTA No. 1. Soil samples examined down to a depth of 4.0 feet at C-4 did not indicate the presence of waste material.

Interviews with golf course personnel indicated that FPTA No. 1 was most likely bladed off during golf course construction. It was not known where the waste material was moved, but it may have been used to fill in nearby low spots. Additionally, Coreholes C-5 and C-6 were located based upon evidence of hydrocarbon waste which was discovered when golf course personnel planted trees during mid-January 1985. The shallow pits for the trees are shown on Figure 4-27 as P-1 and P-2. No trees could be planted due to the strong hydrocarbon odors and the liquid present. The third location was hand augered at C-7 where FPTA No. 1 soil may have been placed. No obvious waste was observed in the soil samples at C-7.

Samples from all four hand auger locations were sent to Radian Analytical Services for chemical analyses as per the statement of work. The results of the chemical analyses are provided on Table 4-15, while those for the organic compounds are presented on Table 4-16. The trichlorofluoromethane detected on Table 4-16 may not reflect actual soil conditions. This compound

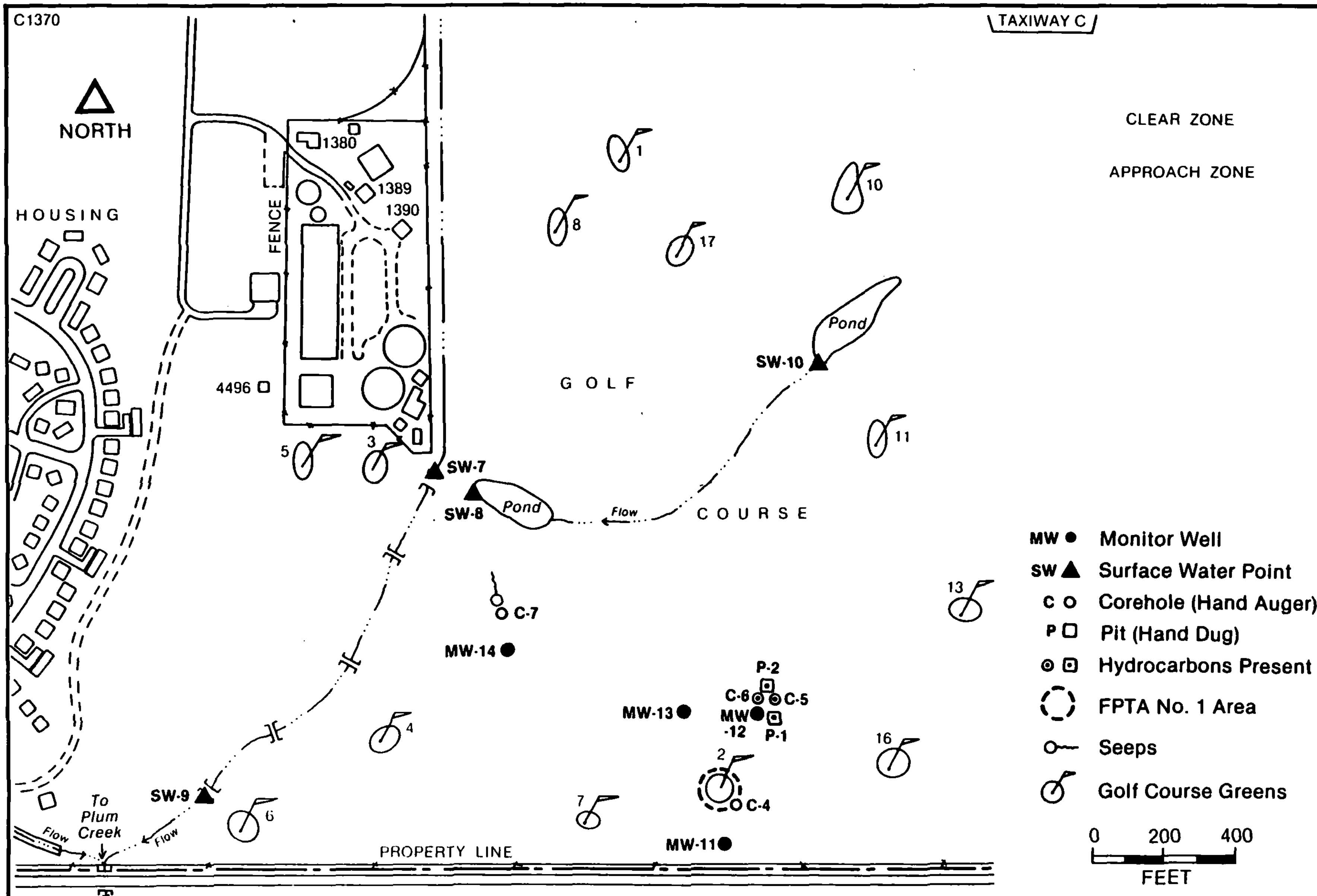

FIGURE 4-27. WATER LEVEL ELEVATIONS AND CONTOURS VICINITY FIRE PROTECTION TRAINING AREA NO. 1, SHEPPARD AFB, TX.

June 1986

TABLE 4-15. COMPOUNDS DETECTED IN SOIL SAMPLES AT FIRE PROTECTION TRAINING AREA (FPTA) NO. 1, SHEPPARD AFB, TX

COREHOLE NUMBER	BASE SAMPLE (number/date)	SAMPLE DEPTH (feet)	PHENOL (ug/g)	TOC (%)	OIL & GREASE (ug/g)	pH (pH units)
C-4	850084 (5/20/85)	3.5 - 4.0	<0.25	0.50	710	8.53
C-5	850083 (5/20/85)	2.0 - 2.5	1.1	-[1]	72,000	8.12
C-6	850082 (5/20/85)	2.0 - 2.5	1.2	<0.01	76,000	7.23
C-7	850085 (5/20/85)	2.0 - 2.5	<0.25	0.73	360	8.02

(1) - denotes Not Detected

TABLE 4-16. ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES AT FIRE PROTECTION TRAINING AREA (FPTA) NO. 1, SHEPPARD AFB, TEXAS

COREHOLE NUMBER	BASE SAMPLE NUMBER AND DATE	SAMPLE DEPTH (feet)	TRICHLORO-FLUORO-METHANE (ug/L)
C-4	850084 (5/20/85)	3.5 - 4.0	-(1)
C-5	850083 (5/20/85)	2.0 - 2.5	92(2)
C-6	850082 (5/20/85)	2.0 - 2.5	88(2)
C-7	850085 (5/20/85)	2.0 - 2.5	-

(1) - denotes None Detected

(2) An air conditioning refrigerant often detected as a spurious analyte which has also been delisted from the priority pollutant list 1981 (46 CFR 2266).

is a very volatile air conditioning fluid, which is often seen as spuriously detected analyte. The high vapor pressure of the compound creates the potential for a sample to acquire trichlorofluoromethane during transit or storage. On the other hand, its presence may be an anlytical interference due to the oil and grease detected on Table 4-15.

Additionally, two soil samples were collected for EP toxicity and ignitability analyses. The results of the analyses are provided in Appendix H.

4.5.2 Significance of Findings

The investigations at FPTA No. 1 were designed to confirm the presence of the old training area and detect contamination migration in the subsurface and nearby surface waters. The geophysical results did not define the boundaries of FPTA No. 1, which is located under the golf course Green No. 2. In addition, the geophysical results indicated an area of high conductivity northeast of the site (Green No. 2) which may be attributable to training site rubble contamination and/or pipes.

Four locations were hand augered to confirm the FPTA No. 1. The results show no contamination in the soil next to the green and nearby drainage feature which would indicate the presence of FPTA No. 1. It is possible, due to the size of Green No. 2, that the hand augering may not have intercepted the old training site. Hydrocarbon waste was confirmed in an area adjacent to the electromagnetic (EM) anomaly in the vicinity of monitor well No. 12. Hydrocarbons would be expected from fire training activities. Both of these areas may contain residue related to the removal of FPTA No. 1 during golf course construction.

The results of ground-water analyses at four monitor wells indicate the presence of organic compounds shown on Table 4-14. All wells indicated some contaminants, but Monitor Well MW-12 shows the largest and highest number of chlorinated solvents. The location of Monitor Well MW-12 is between the area of high conductivity readings shown by the geophysical survey and the oily waste confirmed with hand augering. No organic compounds exceeded criteria for the 1:100,000 risk level (Table 4-2). As can be seen on Table 4-14 some of the organic compounds were only detected during one of the two rounds of sampling. A number of factors can affect the detection of these compounds; particularly since the samples were obtained from an active golf course. These factors can be local weather conditions, golf course activities and analytical variations where the results are low and near the limit of reliable detection for GC methods. Table 4-17 summarizes the total dissolved solids (TDS) measurements that exceeded the federal guideline, based upon drinking water aesthetics. The TDS criteria was exceeded for all groundwater samples, but high TDS is a natural condition for groundwater in this area.

Monitor Well MW-11 is at the apparent outer edge of a ground water mound (Figure 4-26). The mounding effect is likely due to the irrigation of the golf course greens in this area. Ground-water conditions and movement off-Base is unknown. Some movement off-Base and southward can be expected due to the high water levels at Monitor Well MW-11 and its close proximity to the Base boundary. The major flow direction appears to be Base-ward to the north towards nearby ponds and creeks.

Three organic compounds (Table 4-14) were detected at MW-11. These compounds, although only detected once during two rounds of sampling, may be from the contaminated relic soils of FPTA No. 1. Other possible sources could be the nearby landfill or for chloroform, chlorinated water used for golf course irrigation. Similar numbers of compounds were detected in the down-gradient wells of MW-13 and MW-14. None of these exceeded an inorganic or organic criteria. However, compounds detected at Monitor Well MW-12 had the greatest number of parameters detected in ground water, for both rounds of sampling. The significance of this finding is that Monitor Well MW-12 is located downgradient of the FPTA No. 1 area and near a distinct EM anomaly that may reflect subsurface contamination. Therefore, a probable source of contaminants is from the immediate area about Monitor Well MW-12 which may contain rubble material from FPTA No. 1. In addition, other sources of contaminants not associated with FPTA No. 1 are possible, such as from other waste disposal activities in the area. Nearby landfilling has occurred in the past.

EPA Method 602 compounds were not prevalent in the analytical results. These compounds would normally be expected as part of waste fuels used in fire protection training. The analytical chromatographs indicated interferences that probably masked the aromatic compounds (EPA (602) results where the samples had to be analyzed at a 1/50 dilution ratio. The dilution raised the detection limit by a factor of 50.

Surface water points SW-7 and SW-8 both had only one organic compound detected (Table 4-14) neither of which exceeded federal and/or state regulations or guidelines for a 1:100,000 risk level (Table 4-2). Surface water point SW-9 had five organic compounds detected again with none exceeding a criteria. These data are significant in that there is an increase in the number of chemical compounds downstream of surface water point SW-7. Four of the compounds were not detected in the nearby monitor wells. South of SW-7 there is a discharge pipe leading from the Base waste treatment plant that may be a source of these compounds. Contaminated ground water from the golf course may also be a factor since one of the five compounds detected in the surface water was also detected in the ground water. Additionally, compounds were not detected in both rounds of sampling. This is reasonable to expect because the sampling points were at an active stream subject to Base and urban runoff as well as local precipitation events.

The results of analyses of the surface water from three of the four sites (SW-7, SW-8, and SW-9) indicate the presence of inorganic and organic compounds noted on Tables 4-13 and 4-14. TDS exceeded federal and/or state guidelines as shown on Table 4-17. The TDS criteria is based upon aesthetics of drinking water and appears to be a natural component rather than waste site induced. As previously discussed, some organic compounds were detected in one of the two rounds of sampling for either surface or ground-water samples. The significance of the variability between the sampling episodes is related to

TABLE 4-17. WASTE PIT, LANDFILL NO. 3 AND HARDFILL AREA (FPTA) NO. 1. SUMMARY OF GROUND WATER ANALYTE RESULTS EXCEEDING FEDERAL AND/OR STATE REGULATIONS OR GUIDELINES

SAMPLING SITE		ANALYTE AND RESULTS (1) TOTAL DISSOLVED SOLIDS (S) (mg/L)
	GUIDELINE (2)	500 (3) [1,000]
SURFACE WATER		
SW-7		1,400
		1,800*
SW-8		-
		950*
SW-9		-
		760*
GROUND WATER		
MW-11		530
		-*
MW-12		850
		760*
NW-13		1,200
		1,200*
MW-14		1,900
		1,800*
MW-14 QC		1,700 *

(1) Federal and State of Texas primary and secondary drinking water standards denoted by (P) and (S), respectively. Secondary criteria based upon aesthetics for water consumption while primary criteria are based upon health considerations. Regulatory references: Federal Register, 24 October 1980 and 7 September 1979; Texas Department of Health drinking water standards, revised 1 November 1980.
(2) [] denotes State of Texas criteria which is different from Federal criteria.
(3) Guideline concentration in mg/L, analytical results in (mg/L).
* Asterisk denotes results from the second round of sampling.

the fluctuations of surface water flows, drainage sources, local weather conditions, and golf course activities. Analytical variations can affect the results particularly when the results are low and near the limits of reliable detection for GC methods, as in this case. Other sampling would be required to confirm the values and substantiate any environmental concern.

The significant findings are summarized below:

- o EM geophysical surveys did not map the boundary of FPTA No. 1 which is located under the golf course Green No. 2 which was probably scraped off during green construction, also hand augering did not detect FPTA No. 1;

- o Results of geophysical survey and hand augering indicated contaminated areas in the vicinity of Monitor Well MW-12 which is northwest of FPTA No. 1;

- o Monitor Well MW-12 had the largest and consistent number of contaminants detected in ground water;

- o Ground water occurs at the site and primarily flows to the northeast and northwest; and

- o Organic compounds were detected in surface water and ground water. A possible, but unconfirmed, source for these compounds may be discharges from the Base wastewater treatment plant.

5

5.0 ALTERNATIVE MEASURES

This section discusses the alternative measures appropriate for each of the sites investigated. As was discussed in Section 4.0, the occurrence of contaminants is significant primarily within the context of threats to a receptor. Alternative measures are examined as they relate to the potential exposures of candidate receptors. The receptors to be considered are: (1) Bear Creek in the vicinity of the Waste Pits; (2) the unnamed tributary to Bear Creek at Landfill No. 3 and the Hardfill area; (3) underground utilities at FPTA No. 3; and (4) the unnamed tributary to Plum Creek that drains off the installation boundary at FPTA No. 1. The Waste Pits, Landfill No. 3 and Hardfill areas have the potential to impact Bear Creek and its tributaries. Ground water at FPTA No. 3 has the potential to impact on base facilities, the nearby unnamed tributary to Plum Creek, and off-Base. The alternative measures to be considered are:

- Continued monitoring of the existing wells;
- Installation of additional monitor wells;
- Initiation of other sampling (i.e., surface water, hand augering, coring) activities; and
- No further activities.

Following is a discussion of each site with respect to each of the alternative measures listed above.

5.1 Waste Pits

The geological conditions at the Waste Pits have been described in Section 4.0. No ground water was encountered, precluding the need for monitor wells. Furthermore, no apparent hydraulic communication exists with nearby

Bear Creek. Although contaminated clayey soils were confirmed at depth, little possibility exists for leachate generation and migration due to low permeabilities and lack of water. Therefore, installation of monitor wells is an inappropriate alternative measure for this site.

Additional soil sampling in coreholes to define the extent of the contaminated soil is reasonable, although a low potential exists for subsurface migration of contaminants.

Some inorganic and organic compounds were detected at surface water control point SW-1. Upstream at points SW-2 and SW-5 none or few compounds were determined. Two possibilities exist that may account for an increase in detected compounds, assuming that no contribution is occurring from the Waste Pits. First, Bear Creek enters the Base downstream of an off-Base wastewater treatment plant. The creek in this area was not sampled under the present program. Surface water points SW-2 and SW-5 are on a tributary to Bear Creek. Additional surface water sampling may be appropriate to define sources of water contaminants. An additional surface water sampling point could be added where Bear Creek enters the Base. Second, Base hardfilling activities were on-going near the Waste Pits. As only non-hazardous fill and rubble were deposited, it is unlikely this area is a source of contaminants.

Further activities at the Waste Pits to characterize contaminants is the best alternative.

5.2 Landfill No. 3 and Hardfill Area

The geologic conditions at the Landfill No. 3 and Hardfill areas consist of clayey soils. The relic landfill trenches and hardfill areas for most of the site were observed during the field activities. Ground water was found in two areas, but areas of the site appears to be dry. The limited number of borings (i.e., 4) drilled over such a large site (approx. 4000 ft. long) make it uncertain if other aquifers exist; particularly along the Base boundary. Ground water in the northern area near Monitor Well MW-4 is hydraulically connected to the nearby unnamed creek tributary to Bear Creek. In the southern area at Monitor Well MW-7, the ground-water relationship to the adjacent unnamed creek is uncertain. In the absence of data to confirm ground-water flow directions, the off-Base migration of contaminants from the site cannot be discounted.

Continued monitoring of existing wells may be appropriate since organic compounds were detected in Monitor Well MW-4. However, the compounds were detected in only one of two sampling events, not necessarily implying an environmental problem. Additional monitoring would be needed to confirm the presence and nature of the contaminants and to correlate with surface water data.

Installation of additional monitor wells may be considered appropriate because of the variable hydrogeologic conditions that were encountered. It appears that the majority of the site is underlain by clayey soils (locations B-5, B-6 and MW-7). Sandier soils and ground water were found north of the site at Monitor Well MW-4. A seep of ground water was found at Monitor Well MW-7 on the south side. Based upon present data, the ground-water systems are discontinuous and flow directions are unknown.

It is possible that ground water may exist in other locations which could permit off-Base migration of contaminants especially since no data are available on the geologic materials encountered during trenching. Several additional borings placed along the Base boundary could confirm the presence of ground water. If needed, these could be completed as monitoring wells and subsequently sampled. In addition, ground-water flow in the area of Monitor Well MW-4 is also unknown, and two other wells would be needed to define ground-water flow directions and confirm any contamination.

The alternative of further activities is reasonable considering the known hydrogeologic conditions over such a large landfill area.

5.3 Fire Protection Training (FPTA) Area No. 3

The substrate in this area is mainly composed of sand, silt, and clay. The active training area and evaporation pond were studied during field operations. A former evaporation pond, now filled in, was located during field operations. Ground water occurs throughout the site, with flow to the southeast. Organic compounds (i.e., solvents) were detected in the ground water. However, it appears that no immediate threat is posed by contaminants since ground water is not used for Base wells. The nearest Base boundary is approximately 4,500 feet from the site to the southeast.

Continued monitoring of existing wells is considered appropriate since organic compounds were detected in all monitor wells. However, most of the compounds were detected in only one of the two sampling events. Additional monitoring would be required in order to confirm the presence and nature of contaminants over time and with seasonal variations. Of particular interest are contaminants detected in the upgradient area (i.e., MW-8) and downgradient at Monitor Well MW-10 adjacent to the old filled evaporation pond.

Installation of additional monitor wells may be appropriate because the ground-water quality and flow direction beyond the site are unknown; the presence of underground utilities (i.e., storm drains) may affect ground-water flow by acting as a recharge or drain point for ground water, which could drain off Base. Additionally, the source of contaminants at the upgradient area should be confirmed.

Other sampling should be considered at FPTA No. 3. The old unlined evaporation pond should be considered for coring and soil/waste sampling. The old pond may be contributing contaminants to the ground water as evidenced by the large number of compounds that were detected at the nearby Monitor Well MW-10. The presence of ground water next to the storm drain should be confirmed since this can be a pathway for ground-water migration along the drain system to the Base boundary.

The alternative of further activities is warranted based upon present known ground-water conditions.

5.4 Fire Protection Training (FPTA) Area No. 1

The hydrogeological conditions at FPTA No. 1 have been described in Section 4.0. No direct evidence of the old fire training area at the golf course green no. 2 was observed. Shallow ground water occurs at this site and generally flows northward towards the Base. Organic compounds were detected in the ground water from both upgradient and downgradient areas, particularly in the vicinity of Monitor Well MW-12. In the vicinity of Monitor Well MW-12, hydrocarbon wastes were confirmed as well as a suspected contamination area which was also revealed during EM surveys. Organic compounds were also detected in a nearby tributary to Plum Creek. These compounds may be related to the Base surface water runoff and wastewater treatment plant discharges.

Continued monitoring of existing wells should be considered since organic compounds were detected in all monitor wells. Monitor Well MW-12 had the greatest number of compounds detected in both rounds of ground-water sampling, while for the other wells, fewer compounds were detected and only during one of the rounds of sampling. These findings are significant since migration of contaminants is toward the Base. In addition, the ground-water discharges to a nearby creek and several ponds that flow off-Base. Minor southward flows off-Base can also be expected in the vicinity of Monitor Well MW-11 where the ground-water levels are relatively high. Continued monitoring would be needed to confirm the presence and nature of contaminants over time with seasonal variations.

Installation of additional monitor wells may be appropriate since the ground-water quality and flow conditions beyond the current monitor wells is unknown. Of particular interest is the area downgradient of Monitor Well MW-12 where the greatest contamination was detected. This would also aid in defining the potential contamination plume.

Additional sampling should be considered at FPTA No. 1. Specifically, hand-coring should be conducted in the area of Monitor Well MW-12 to define the extent of hydrocarbon waste and to detect possible contamination at a nearby geophysical anomaly. Hydrocarbon waste was found in the area which appears to be contributing chemicals to the ground water. This contamination may be occurring from rubble from the old training area.

Surface water samples should also be taken simultaneously with water samples from the monitor wells. An additional site should be included at the confluence of the wastewater treatment plant discharge and the creek.

The alternative of further activities is warranted based upon present ground-water conditions.

6

6.0 RECOMMENDATIONS

This section contains the Phase II (Stage 1) IRP recommendations regarding further actions at Sheppard AFB. According to previously provided U.S. Air Force criteria, each of the four sites has been assigned to one of the following categories:

- Category I — Sites where no further action is required;
- Category II — Sites requiring additional monitoring or work to assess the extent of current or future contamination; and
- Category III — Sites that require and are ready for remedial action.

All sites investigated during the Stage 1 program fall into Category II, requiring additional monitoring to more clearly define and assess the extent and character of contamination. Every site investigated had evidence of some soil and/or ground-water contamination. The hydrogeologic and chemical data for most sites was generally not sufficient to adequately define the physical environment to the extent required for the design and implementation of remedial actions. Each site was surveyed and evaluated according to the Delivery Order specifications; however, data gaps exist with respect to an adequate characterization. No sites were assigned to Category III due to insufficient evidence.

The following sections present the recommendations and basis for further action recommended for the Stage 1 sites. The sites are grouped by category and are presented in order of priority on Table 6-1.

TABLE 6-1. CATEGORIZATION OF SHEPPARD AFB IRP, PHASE II STAGE 1 SITES

CATEGORY	SITE	PRINCIPAL RATIONALE
II	Waste Pits	No ground water was encountered. Although low potential for contaminant migration was determined, further characterization of contamination is recommended.
II	Landfill and Hardfill Area	Additional characterization of the local ground-water systems, and contaminant verification is needed.
II	FPTA No. 3	Characterization of an old evaporation pond suspected of contaminating ground water is necessary. Verification of ground water and contaminant flow direction beyond the site and upgradient of the site is necessary.
II	FPTA No. 1	Characterization of hydrocarbon waste is needed and definition of a contamination plume is required.

6.1 Category I Sites

Category I sites are defined as sites where no further action is required. No sites were identified for Category I consideration.

6.2 Category II Sites

Category II sites are defined as sites requiring additional monitoring work or work to quantify or further assess the extent of contamination. The sites listed in Category II are: (1) Waste Pits, (2) FPTA No. 1, (3) FPTA No. 3, and (4) Landfill No. 3 and Hardfill Area. None of these sites appears to pose any immediate threats to identified receptors. Based upon the results of the investigation discussed in Section 4.0 and the alternative measure considerations noted in Section 5.0, the following general recommendations are provided for these sites.

Waste Pits

1. Conduct soil coring and sampling to verify the contaminants detected. Three coreholes will be drilled in the Waste Pits with one corehole in each pit. Analyze selected soil samples for purgeable halocarbons, purgeable aromatics using a gas chromatography/mass spectroscopy (GC/MS) method. Other analyses will be oil and grease, TOC, pH, phenol, EP toxicity and ignitability.

2. Install five lysimeters at the Waste Pits. Two lysimeters are to be placed within the Waste Pit area. The other three lysimeters will be placed outside of the Waste Pits. The lysimeters will be to sample and characterize contamination that may be contained within low permeable materials.

3. Install four piezometers at the Waste Pits. Three will be placed around the pits while one will be within the pit area. These

piezometers will be to confirm the presence and gradient of ground water as well as establish the hydraulic relationship, if any, with the adjacent Bear Creek.

4. Conduct monitoring of the lysimeters and piezometers installed at the site by conducting quarterly sampling and water level measurements, respectively, for one year. This will be to establish seasonal variations and contamination confirmation as well as provide baseline data confirmed contamination. The chemical analyses should be for the analyses used during the IRP Phase II Stage 1 investigation: purgeable halocarbons, purgeable aromatics, oil and grease, total organic carbon, pH, total dissolved solids, and phenol. Where appropriate, GC/MS analytical methods will be used.

5. Conduct quarterly water sampling and water level measurements of the surface water point (SW-1) at the site. Water samples collected will be analyzed for the parameters described in item 4 above. Monitoring of this surface water point will aid in confirming Waste Pits impacts on the creek, if any. Also, this will establish the hydraulic relationships of the creek with any groundwater under the Waste Pits.

6. Conduct an off-Base water well inventory within 1/4 mile of the Base boundary from the Waste Pits. This will provide data to verify any uses (i.e., domestic or municipal) of shallow ground water that may be impacted by off/Base ground-water flows. The primary well data can be obtained from state and local records. The present well condition and status can be verified in the field as well as detecting wells for which no State record may exist.

7. The site is on a flood plain area of Bear Creek. Free standing water and flooding should be prevented in this area to reduce the possibility of leachate migration in the subsurface.

8. In the past, the area around the Waste Pits has been used for earth-moving construction training. Therefore, the Waste Pits area should be identified on Base records to preclude any future disturbance of the site. This action would also minimize the possibility of personnel exposure to possible contaminants.

9. Auger cuttings that were containerized during the Stage 1 activities can be disposed of as landfill material since they were found to be non-hazardous (based upon EP toxicity and ignitability testing).

Fire Protection Training Area No. 1

1. Conduct shallow hand augering and soil sampling to verify the extent of the hydrocarbon wastes detected in the vicinity of Monitor Well MW-12. Additionally, conduct hand augering at an adjacent area suspected of contamination as inferred through the geophysical surveys. Select samples for chemical analyses for phenols, oil and grease, and volatile organic chemicals in soil using a gas chromatography/mass spectroscopy (GC/MS) method.

2. Install three monitor wells downslope from Monitor Well MW-12 where known contaminants were confirmed but ground-water flow beyond the site is unknown. Since ground-water levels were within several feet of the surface, it is considered appropriate to hand-emplace stainless steel well points. Chemical analyses should be for EPA Methods 601 and 602 with double column confirmation, phenols, oil and grease.

3. Conduct an off-Base water well inventory within 1/4 mile of the Base boundary from FPTA No. 1. This will provide data to verify any uses (i.e., domestic or municipal) of shallow ground water that may be impacted by off-Base ground-water flows. The primary well data can be obtained from state and local records. The present well condition and status can be verified in the field as well as detecting wells for which no State record may exist.

4. Follow-up monitoring of wells installed at the site by conducting quarterly sampling and water level measurements for one year. As solvents were the main contaminants, the chemical analyses should be for EPA Methods 601 and 602 with double column confirmation. This will be to confirm and determine seasonal contamination variation as wells as provide baseline data for remedial actions.

5. Conduct quarterly water sampling, for one year, of the three surface water points for analyses using EPA Method 601 and 602 with double column confirmation. Add a sampling point at the wastewater treatment plant discharge to the creek. These will be to correlate analytical results with seasonal ground-water discharges.

6. Auger cuttings that were containerized during drilling can be disposed of as landfill material since this material was found to be non-hazardous (based upon EP toxicity and ignitability testing).

<u>Landfill No. 3 and Hardfill Areas</u>

1. Conduct two borings along the western Base boundary and if ground water is found, install two monitor wells. This will be to confirm any ground water aquifers and potential for off-Base migration. Sample and analyze ground water as noted in Item 4 below.

2. If ground water is confirmed along the Base boundary, conduct an off-Base water well inventory within 1/4 mile of the boundary from the site. This will provide data to verify any users of shallow ground water that may be impacted by off-Base ground water flows. The primary well data can be obtained from state and local records. The present well condition and status can be verified in the field as well as detecting wells for which no State records may exist.

3. Install two monitor wells upgradient of Monitor Well MW-4 where contaminants were identified. Sample these wells quarterly for one year. Analyze for the parameters noted in Item 4 below. This information will be used to determine ground water flow directions and confirm contamination.

4. Conduct follow-up monitoring of wells installed at the site by conducting quarterly sampling and water level measurements for one year to establish seasonal variations and contamination confirmation as well as provide baseline data if contamination is confirmed. The chemical analyses should be for the analyses used during the IRP Phase II Stage 1 investigation: purgeable halocarbons, purgeable aromatics, oil and grease, total organic carbon, pH, total dissolved solids, metals (Cr, Pb, and Hg), and phenol.

5. Conduct quarterly water sampling of the surface water points at the site for analyses described in Item 4 above. Add a new sampling site where Bear Creek enters the Base. These will be to correlate analytical results with seasonal ground-water discharges.

<u>Fire Protection Training Area No. 3</u>

1. Conduct quarterly water sampling for one year of the surface water point at the present evaporation pond for analyses using EPA Method

601 and 602 with double column confirmation, oil and grease, and total dissolved solids. These analyses will be for correlating pond water contaminants with analytes detected in the ground water.

2. Conduct a detailed examination of the storm drain and other utilities at the site to identify possible ground-water contamination recharge and/or discharge points which could exit the Base. Several borings should be drilled next to the utility line to verify the presence of ground water in the storm drain emplacement trench along with contaminants could migrate acting as as a short circuit to other areas of the Base and/or off Base. Additionally, contaminated ground water could flow into the storm drain to potentially drain off Base. If water is found, obtain a grab sample for chemical analysis described in Item 1 above.

3. Conduct soil coring and sampling to verify and accurately define the old evaporation pond and former fire training pit. Analyze selected soil samples by method SW-8010 and SW-8020 in addition to oil and grease.

4. Follow-up monitoring of wells at the site by conducting quarterly sampling and water level measurements for one year to establish seasonal variations and contamination confirmation. The chemical analyses should be for EPA Methods 601 and 602 with double column confirmation, oil and grease, and total dissolved solids.

5. Install three monitor wells downgradient from Monitor Well MW-10 where known contaminants were confirmed but ground-water flow beyond the site is unknown. Chemical analyses and water level measurements should be the same as in Item 4.

6. Install two monitor wells upgradient of Monitor Well MW-8 where contaminants were identified and sample quarterly. Analyze for the parameters noted in Item 4 above.

7. FPTA No. 3 was unlined evaporation pond during this study. Consideration should be given to line the pond to reduce the infiltration potential of stored fluids.

8. Auger cuttings that were containerized and which were not found to be hazardous based upon EP toxicity and ignitability testing can be disposed of as landfill material.

6.3 Category III Sites

No sites were identified for remedial action under the IRP Phase II Stage 1 confirmation investigation.